ELEMENTS OF BOTANY.

ELEMENTS OF BOTANY,

OR

OUTLINES OF THE NATURAL HISTORY

OF

VEGETABLES.

ILLUSTRATED BY FORTY ENGRAVINGS:

BY BENJAMIN SMITH BARTON, M. D.

President of the Philadelphia Linnæn and Medical Societies; one of the Vice Presidents of the American Philosophical Society; Member of the Imperial Society of Moscow in Russia; and Professor of Materia Medica, Natural History and Botany, in the University of Pennsylvania.

A NEW EDITION:

REVISED AND CONDENSED,

WITH AN ACCOUNT OF THE LIFE AND WRITINGS OF THE AUTHOR,

BY WILLIAM P. C. BARTON, M. D.

A Senior Surgeon of the U. S. Navy; Formerly Professor of Botany in the University of Pennsylvania; and of Materia Medica and Botany in the Jefferson Medical College of Philada.; and now Lecturer in the Therapeutic Institute of Philadelphia; for teaching Botany, Materia Medica, &c.

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PREFACE.

The public is now presented with an edition of these Elements which, it is believed will be more useful than any former one. The work has been condensed from two volumes, into one, although the edition cannot be considered as an abridgement, in the usual appropriation of that term to voluminous works. The condensation consists in the omission, 1st, of all poetical quotations from the Latin and English classics. How apposite and interesting soever they may have been, they had the effect of swelling the work if not in some degree interrupting the scientific detail.—2dly, in omitting the tabular views (at the end of vol. 2,) of the antiquated and disused systems of botanical classification, and arrangement—3dly,in altogether expunging the index, because in such a work, the index necessarily becomes too copious for facility of reference—4thly, in leaving out more than one half the paragraphical disposition of the matter, thus rendering the pages more continuous.—Finally, by throwing all the references of the two volumes into one mass for each plate.

I have not felt freedom either in my feelings of respect for the learning of the author, or in my sense of justice to his views on the subject of elementary botany, in any degree to alter or to modify the details of vegetable physiology and nomenclature, or to intrude any extraneous matter of my own in the form of notes. In a word, I have made it a matter of conscience to change nothing but the disposition of the matter, except in the instance where some diffuseness of the style, rendered condensation proper and necessary, to meet the object of the edition. The work is therefore, the unmutilated and ungarbled work of the late professor Barton, *in toto;* I feel that while I have scrupulously preserved its originality, by acting in the revision of the labours of that eminent man of science, as if he were alive and his eye upon me, I have not found this faithful discharge of a trust imposed on myself with restriction and fastidiousness, at all incompatible with the determination to render the work more useful in its present, than it has been heretofore found in its former state.

WILLIAM P. C. BARTON.

Philadelphia Nov. 18, 1836.

A BIOGRAPHICAL SKETCH

READ PURSUANT TO APPOINTMENT, BEFORE THE PHILADELPHIA MEDICAL SOCIETY, AT A STATED MEETING, FEBRUARY 16, 1816, OF THEIR LATE PRESIDENT,

PROFESSOR BARTON,

BY WILLIAM P. C. BARTON, M. D.

AN HONORARY MEMBER OF THE SOCIETY.

" At a Stated Meeting of the Philadelphia Medical Society, held at their Hall on Saturday, the 23d of December 1815:—

" Resolved, 1st. That the Society view with sentiments of deep regret the death of Professor B. S. Barton, as an event which has deprived the Society of the useful labours of a worthy President, the University of Pennsylvania of one of its brightest ornaments, the Medical profession of one of its most erudite members, and the United States of one of its most distinguished and useful citizens.

" Resolved, 2dly. That a committee be appointed to wait on Dr. Wm. P. C. Barton, to request, him to prepare and read before the Society, a Biographical sketch of the late Professor Barton, previous to the termination of the present Course of Lectures."—(Extract from the Minutes of the Society.)

GOUVEYNEER EMERSON, Secretary.

" At a Stated Meeting of the Philadelphia Medical Society, held at their Hall, on Saturday the 24th of February, 1816:—

" Resolved, That the thanks of the Society be presented to Doctor Barton, for the very appropriate Biographical Sketch of the late Doctor Benjamin Smith Barton, which he has read before the Society, and that a copy of the same be requested for publication.".

(By Nathaniel Chapman, M. D. President, and Samuel Calhoun, M. D.)

(Extract from the Minutes of the Society,)

GOUVEYNEER EMERSON, Secretary,

A Biographical Sketch of Professor Barton.

Benjamin Smith Barton, a younger son of the late reverend Thomas Barton, a learned episcopal clergyman, long resident at Lancaster in this state, was born in that opulent and comparatively ancient borough, on the 10th day of February, 1766. He bore the intermediate name of Smith (given to him at his baptism) in token of the intimate friendship that had subsisted, during a period of twenty-five years, between his father, and the then learned provost of the university, of that name, by whom he was baptised.* His mother was a sister of the celebrated Rittenhouse. Both his parents were eminently qualified to infuse into the minds of their children, the rudiments of knowledge, and the principles of virtue; but unfortunately, their younger children were too soon deprived of these advantages. The subject of this memoir lost his mother when he was little more than eight years of age; and though his father's death did not happen till he had attained his fourteenth year, he was bereaved of the parental care and instruction of one of the best of parents, about a year and a half before that event. His father left Pennsylvania early in the autumn of 1778, intending to proceed to Europe; but he was arrested by sickness before he could, with convenience, embark, and never returned. Thus at the age of fourteen was his son Benjamin left an orphan.

Mr. Barton had, however, before his departure from Lancaster, taken care to provide for his minor children, a suitable and convenient place of abode in the neighborhood of that town: where they were placed in the midst of many of his best and most faithful friends, and under the immediate superintendance of a person of great worth and long experienced friendship for the family. Comfortably situated in this pleasant rural retirement, this little household continued between one and two years: and there, abstracted from the noise and bustle of a town, our youthful student—ever assiduous from a very early period of his life, in the acquisition of knowledge,—devoted much of his time to reading. He never appeared to be fond of those active bodily pursuits and athletic exercises, in which boys employ much of their time; though he occasionally engaged in them. The scene around him was well adapted to the contemplation of nature, and he was of a contemplative turn of mind. His inclination seemed, at that period of his

* Dr. William Smith.

life, to direct to the study of civil history; of which he very early acquired a considerable knowledge: but it is not improbable, that having during the life of his father, and while under his roof, acquired some taste for natural history and the culture of plants—subjects to which that gentleman devoted much of his attention*—the objects of this kind by which he was surrounded while in the country, may have drawn his mind to similar pursuits, and the cultivation of natural science generally—certain it is, that his predilection for natural history—more especially for botany—discovered itself very early.

In the spring of the year 1780, our young student (with one of his brothers) was removed to the town of York, in this state, where he was placed in an academy, then under the direction of that accomplished scholar, Dr. Andrews, late provost of the university, and who had himself been a student of divinity of Dr. Barton's father. There he continued nearly two years; and, having his studies directed, during that time, by so able a preceptor, the student, aided by his own genius and great application, acquired that critical knowledge of the learned languages, more especially of the Latin, which formed so prominent a feature in his literary attainments. Young as he then was, he read the Greek and Roman authors with avidity, and became enamoured of classic learning:—this is strongly evinced by many of his juvenile letters to his brother William, between September 1780, and March 1782, considering this brother the eldest of the family—as he then did—in the light of his natural guardiam and best friend; a character in which he repeatedly recognized him.

At the age of sixteen years, this young scholar made his first attempt in composition, in an "*Essay on the vices of the times.*" This essay

* It appears by a paragraph in a note to the "Observations on the desiderata of natural history," that Dr. Barton's father had paid very considerable attention to some part of natural history. Speaking of tin, which upon the authority of Gronovius, Dr. Barton says has been found in Pennsylvania he has the following remark: "If I do not greatly mistake, there were specimens of tin in the fine collection of North American minerals, which was made by my father near forty years ago, at a time when he paid more attention to this part of natural history than so far as I know, any other person in the (then) colonies. The greater part of my father's collection was sent to England; but falling into the hands of those who knew but little of its value, it has never been heard much of, or mentioned in any of the printed accounts of minerals that I have seen."

There is moreover, in the family, and I believe now among the late Dr. Barton's manuscripts; a letter from Linnæus to the doctor's father in which he tells him that *Cuscuta Europea* (a little twining parisitick plant) will probably be found in America, and stating that the plant generally (then) called by that name, was a distinct species and should be called *Cuscuta Americana.* This letter (and there may have been more) seems to imply that the reverend Mr. Barton had paid some attention to botany, and had even corresponded with Linnæus on the subject.

is still in existence. It bears testimony to the early genius and discernment of the writer, and possesses no inconsiderable portion of merit, even in point of style. He manifested too, very early in life, a vivid fancy for drawing; and in the execution of his designs with the pencil, at an immature age, he discovered that taste and genius in the art, which he afterwards cultivated with much success, and prctised, in occasional hours of leisure with great accuracy. This was a talent that he often rendered subservient to his pursuits in natural history and botany;* branches of science which are greatly assisted in their acquisition by the investigator possessing, himself, a facility in copying the subjects appertaining to them. Besides his extreme neatness, faithfulness and truth, in the delineation of natural objects, more particularly of plants, by the pencil, he acquired great adroitness in the beautiful art of etching on copper, and I have now in my possession, among other efforts of this kind, the figure of a dog, which exhibits the most true and perfect attainment of this nice art I have ever seen—It was made about five years ago. Dr. Barton did not despise these adventitious aids of science, and he often declared it as his opinion, that no man could become a nice, discriminating, and eminent botanist, without possessing that acumen in preception of proportion, colour, harmony of design, and obscure differences in the objects of the vegetable world which alone belong to the eye of a painter. The accuracy, the vividness, the sensibility (if I may be allowed the expression) of his eye, were truly wonderful. I dwell more on these points than in the estimation of some, perhaps they may seem to merit, because they have a near relation to the authenticity of the engravings that accompany some of his works. I *know* they may be be relied on, for what passed *his* inspection and received *his* approbation, in this way; must be faithful as the pencil and the graver could make them. Those who painted the subjects of natural history† for him know, and those who have multiplied those paintings by the graphic art also know, and can verify the statement I have given, of his uncommon perception of errors, in drawings and engravings. It always took quick cognizance of those

* The following extract from a letter written by Dr. Barton to his cousin, July 14, 1785, from the western boundary of Pennsylvania, shows that he very early applied his talent for painting to a useful purpose:

"Tell H—— she may depend upon the promise I made her, of drawing her a landscape; and probably some other pictures. I have already taken drawings of several curious and beautiful flowers, together with one of the falls of the river Youh: this last I will send her as soon as a safe opportunity offers."

BENJAMIN BARTON.

† I have frequently painted these subjects for him, and can therefore speak with the more certainty of the fact. In all my drawings made for him, whether of plants, animals, bones, &c. I learnt the absolute necessity (to please his eye) of adhering very faithfully to my models. The first lessons I ever received of scrupulous correctness in drawings of this nature, were from him.

defects, which other delineators of natural objects, or, in different words, other naturalists who suffer the authenticity of their names to accompany unfaithful or caricatured representations of the works of nature, too frequently allow to escape their observation, and in this way bring into disrepute the real advantages derived from pictured illustrations.

In the year 1782 the eldest brother of the subject of this memoir, took him into his family in this city, in which situation he continued between four and five years. During this period he prosecuted his collegiate and medical studies; the first in the college of Philadelphia, where however he did not take the degree of bachelor of arts, and the latter under the celebrated anatomical professor Dr. William Shippen, with whom he commenced the study of medicine, in the beginning of his eighteenth year.

While he was yet a pupil of Dr. Shippen, he accompanied his uncle, Mr. Rittenhouse, and the other commissioners appointed for that purpose, in running the western boundary line of Pennsylvania. On this occasion he was absent from Philadelphia about five months, having set out with the commissioners in May, 1785, and returned in October following. He was then only between nineteen and twenty years of age, but from his scientific acquirements he was an useful associate of the commissioners. It was in this excursion that he first had an opportunity of mixing with the savage natives of this country—then he first turned his attention to their manners, their history, their medicines and pathology, and to other interesting points of enquiry; all of which he pursued with great zeal for the remainder of his life. His researches on these subjects; are among the most ingenious, if not the most useful of his labors. They enriched his philosophical inquiries and speculations with curious facts, and enchanced the value of his investigations of the materia medica and alimentaria, with some of their most important additions.

Dr. Rittenhouse, who early perceived and acknowledged the talents of his young relative, procured for him this important situation—important, as it gave the first impulse to that spirit of inquiry and research into the history of our Indians, which has resulted in an ac-

In fact he was, if I may be allowed to use such language, religiously conscientious not to suffer any things of this nature to pass with his name, unless they were true and faithful representations. In evidence of this I will only mention this one fact,—that in the drawing of the horny lizard, of which he has had a superb engraving made, he caused every spinous process or horny protuberance (which were exceedingly numerous) on the back, tail, and legs of the animal, to be distinctly and separately counted, and made to correspond, *even in number*, in the drawing. This indeed may be considered as overreaching the point of necessary truth, and I so considered and still consider it; but it at least must be received as a remarkable evidence of a wish to adhere to faithfulness in portraits of nature.

cumulation of so many curious materials relative to their origin and the affinities of their language.

This learned man continued to Dr. Barton, through life, a firm and a constant, as he was an illustrious friend. In a letter published in the memoirs of Rittenhouse, the doctor thus acknowledges the succour and the patronage he received from his distinguished relation:

"He was dear to us both, to all his relatives and friends, and to his country. To me, let me add, he was *peculiarly* dear. The most happy and profitable hours of my life were passed in the society of this virtuous man. I followed his footsteps in the wilderness of our country, where he was the first to carry the telescope, and to mark the motions and positions of the planets. In the bosom of his family, I listened to his lessons, as an humble disciple of Socrates or Plato. Science mixed with virtue was ever inculcated from his lips. But to me Mr. Rittenhouse was more than a friend and preceptor. *He was a father and supporter.* He laid the foundation of what little prosperity in life I now, or may in future enjoy: and if it shall ever be my fortune, either by my labours or my zeal, to advance the progress of science, or to reflect any honour upon my country, I should be the most ungrateful of men, if I did not acknowledge and wish it to be known that it was *David Rittenhouse* who enabled me to be useful.*"

Towards the close of the following summer, Dr. Barton embarked for Great Britain, with the view of prosecuting still further his medical studies at the university of Edinburgh. He remained at that school about two years; except some few months in the earlier part of the year 1787, which he passed in London. During his residence in Edinburgh he applied himself with unremitted zeal to his professional studies, attending very regularly the lectures of the eminent medical professors who then taught in that university.

In his letters from that place to his brother William, he mentions in terms of high respect the late doctors Walker, Gregory, Black and Hume; from all of whom, particularly the first named, who was the professor of natural history, he received the most marked attentions. Indeed he frequently, in his lectures on natural history, introduced the name of Dr. Walker, and ever spoke of him in terms of unbounded respect, and even veneration. He thought he owed much of his success in pursuits of natural history, to the kind encouragement of this professor, united to the fostering and encouraging notice and friendship of the late Mr. Thomas Pennant, a well known and distinguished English naturalist, with whom he was long in habits of correspondence and good fellowship. As an evidence of his high respect for this great man, he named his only son after him, and often spoke in terms of satisfaction of this circumstance, since he said his motives for the compliment could never be misconstrued, Mr. Pennant having died a considerable time before his friend gave his name to his son.

* See Barton's Memoirs of Rittenhouse, p. 445.

It appears from a letter to his brother, dated at Edinburg on the 29th of September, 1789, that his health, even at that early period of his life, had been delicate. "My spitting of blood," says he, "has left me, and I am no longer tortured with the gout." In the same letter he mentions, that he had then lately received his diploma from the Lisbon academy; and that Dr. Rush had written him a very polite and friendly letter. At Edinburgh he experienced many marks of the respect in which his talents were there held. Young as he was at that time, he obtained from the Royal Medical Society at Edinburgh —of which he was admitted a member before he had been a year in that metropolis—an honorary premium for his dissertation on the Hyosciamus niger* (of Linnæus)—This was the Harveian prize. About three years ago he received the prize (the first having been lost.) It consists of a superb quarto edition of the works of William Harvey, elegantly bound and gilt: on the fly leaf of which is the following inscription in manuscript, and signed by the elder Dr. Duncan.

Hanc ingenii mercedem
æquo jure decretam
Viro generoso Benjamini Smith Barton, Pennsylvaniensi:
Propter ægregiam dissertationem
de Hyosciamo nigro,
publice tradendam curabat
Sodalitas Edinensis Filiorum Æsculapii,
Festo solemni in Harveii honorem institute,
Pridie Idus Aprilis
1787
Andreas Duncan, senr. a secret.

While Dr. Barton was in London in the first part of the year 1787, he published there a little tract, entitled "Observations on some parts of Natural History: to which is prefixed an account of some considerable vestiges of an ancient date, which have been discovered in different parts of North America." This is called Part I, and is inscribed to his eldest brother. It appears that he intended to have completed his work in one octavo volume, consisting of four parts on the subject of natural history; the first, as he observes in the preface, being a distinct work, having no connexion with that branch of science. This was the first work he ever published. Although in this little book the Dr. evinced much ingenuity and a laudable spirit of research in relation to the antiquities of his native country, the work is evidently the performance of a young writer, and, in fact, the author was then only in the twenty-second year of his age: besides, it was written under the pressure of bodily infirmity, occasioned by ill health, and amidst many discouraging circumstances. Indeed, he soon regretted the 'premature' publication of the work; for he candidly acknowledged its defi-

* A deleterious plant, commonly known by the name of Black-henbane.

ciences, within a few months after its appearance. Speaking of it, in a letter of the 29th of Sept. 1787, addressed to his brother from Edinburgh, he said, "when you write to me, do give me your unreserved opinion concerning this premature performance; let me however previously observe, that I am already ashamed of many parts of it; and I am confident my language has made you smile. But perhaps an apology may be urged in my behalf: the subject is entirely new, and the work was written at a time when the mind was in that fickle and inconstant state, so frequently the attendant and consequence of disease. Notwithstanding all its imperfections, I am not sorry that I have given the work to the public: I have at least the credit of having directed the attention of the world to a curious and interesting inquiry—but peculiarly so to an *American*. You will say, my hypotheses are *puerile* and *crude;* but can they be more so than the hypotheses of antiquaries on most subjects?—I think not. You will also say I should have suffered my work to lie on the shelf for a few years; but then the facts I have given to the world would have been all this time unknown." These frank confessions of faults do honour to a young author, more especially, to one who afterwards acquired so much literary fame as the late Professor Barton. They are introduced on this occasion, as a laudable example of candour, in a man of great intellectual powers—as one worthy of being imitated by all young authors too tenacious of their own opinions. Yet after all, the book in question, is by no means so deficient in merit, as its author, himself, seemed to consider it. On the contrary, it does credit to so young a writer.

For reasons which he communicated to his brother by a letter dated at London, on the 2d of February, 1789, Dr. Barton chose to obtain his medical diploma from the celebrated German university, founded by George the II, at Gottingen, in the duchy of Brunswick, rather than to apply for one which he was entitled to receive, from the university of Edinburgh. With these reasons, there might, perhaps, have been blended some degree of dissatisfaction with the department of two of the professors in the medical school of the latter, towards him; one of these to whom on his arrival at Edinburgh he presented an highly recommendatory letter from his preceptor in medicine, professor Shippen—never showed him the slightest attention; and the conduct of the other was, *as he conceived,* reprehensible for a similar cause. Yet, while he acknowledged with gratitude and a commendable pride, the very polite and friendly attention with which he was honoured by all the other professors, it can scarcely be doubted that circumstances of this nature would have increased—if they did not originally excite, in the mind of a young man of quick sensibility, those unpleasant sensations which he then experienced. But however this may have been, certain it is, that he determined to graduate at Gottingen. I have not been able to ascertain at what time he visited the German university, for that purpose. It appears that he repaired to the continent of Europe, after he finally left Edinburgh in the autumn of 1788: con-

sequently, he must have gone to Gottingen between that period, and the time of his departure from England, in the latter end of July 1789, on his return to America. It may be proper to notice in this place, that whilst in London, Dr. Barton was treated with great kindness and attention by the celebrated Mr. John Hunter, in consequence of his presenting to that illustrious anatomist, an introductory letter* from Professor Shippen. It appears also, from the doctor's letter last referred to, that while in London, in the winter of 1788–9, some favourable proposals were made to him to settle in Russia: but his strong attachment to the country of his birth, and to his relatives and friends in that country, induced him to decline the acceptance of an invitation, which would, probably, have been highly acceptable to a young man of equal ambition and less feeling. He received while in England very uncommon proofs of friendship and regard, from the late Dr. Lettsome.† These Dr. Barton duly appreciated, and in a dedication of one of his works‡ to him he says, "Your attentions to me, during my residence in London, in the year 1787, were those of a kind and affectionate friend, and cannot be readily forgotten. Nor have you withdrawn your attentions, notwithstanding the distance by which we are separated from each other."

After an absence of somewhat more than three years, Dr. Barton arrived at Philadelphia, from London, and was immediately received into the family of his eldest brother, with whom he had always corresponded from his earliest youth, when residing at a distance from him. He remained in his brother's family a few months, until he was enabled to make suitable arrangements, and to provide himself with a convenient situation, for establishing himself in the practice of physic, in this capital: he had then completed the twenty-fourth year of his age.

The well known abilities of Dr. Barton, introduced him speedily into notice, and soon after he began to get into some practice as a physician. By his reputation, too, for attainments in natural science, he acquired literary and academic honours, at a period of life when, in ordinary cases, the conferring of such would be deemed premature; for soon after his return to America,§ he was chosen a member of the American Philosophical Society in this city, of which he became on the 1st of Jan. 1802, one of the vice-presidents, an office he continued to hold till the day of his death. From the first period of his elec-

* This letter was accompanied by drawings of the Ohio bones.

† I was introduced to this eminent physician when in London, about four years ago, by my friend the present Dr. Rush; and the warm and friendly manner of his inquiries after his old friend strongly evidenced, that the high esteem he had conceived for him, was neither abated by time, nor effaced by distance.

‡ Collections for an essay towards a materia medica of the United States—Part second, 1804.

§ On the 16th of January 1789.

tion to membership of this society, he became one of its most active, as he was one of its most intelligent members. The printed transactions of the society are evidences of this. They contain many papers on various subjects relating to natural science, from his pen.

I have now arrived at that period of the life of Dr. Barton, in which he made his *debut* on the theatre of science, as a public teacher. Previously to doing this, however, I pray your patience for a few moments, while I take a necessary retrospect of the beginning of this great medical school, which now vies with the farfamed universities of Edinburgh and Leyden.

In the year 1765, the original plan of the college of Philadelphia, was greatly enlarged, by the addition of the medical school; with the appointment of professors for reading lectures in anatomy, botany, chemistry, the materia medica, the theory and practice of physic, and also for delivering clinical lectures in the Pennsylvania hospital.

Dr. William Shippen the younger, first filled the anatomical chair in the College of Philadelphia, afterwards the University of Pennsylvania, which he continued to occupy for nearly forty-three years, with great respectability. He may justly be considered as the founder of the medical department of this school. He embarked alone in the capacity of private lecturer on anatomy in the winter of 1762—3 being the first winter after his return from his studies in Europe. His success as a private lecturer, demonstrated the expediency of engrafting a medical school on the College of Philadelphia, and in consequence, he was unanimously elected the professor of anatomy and surgery, on the 17th of September, 1765. This able teacher held that chair until his death, which occurred the 11th of July, 1808, in the seventy-fifth year of his age.* I have been more particular in relation to Dr. Shippen, because he was, as I have just stated, the founder of the medical school; for until he delivered lectures in Philadelphia, the voice of a public lecturer had never been heard here. Dr. Adam Kuhn, now living and in the practice of medicine in this city, who had been a pupil of Linnæus at Upsal, was appointed professor of botany, connected with the materia medica. The late eminent Dr. Rush was appointed to the chair of chymistry, and Dr. Thomas Bond, an ingenious and eminent physician, gave clinical lectures in the Pennsylvania Hospital. In the year 1789, the trustees of the college of Philadelphia instituted a professorship of natural history and botany, which was conferred on Dr. Barton, then only twenty-four years of age. Dr. Kuhn had previously to this delivered some courses of lectures on botany, but natural history had never before been taught. Dr. Barton then was the first lecturer on natural history in Philadelphia, and, so far as I know, the first teacher of natural science in the cis-atlantic world. This appointment was confirmed to him in the year 1791, on the incorporation of the college with the University of Pennsylvania. Dr.

* See Barton's Memoirs of Rittenhouse.

Barton, at the period of his death, had held this professorship for the space of six-and-twenty years. I beg leave in relating the benefits to natural science that resulted from the labours of the late industrious Professor, to quote what I have published on this point in the preface of my Prodromus of a Flora Philadelphica. "During this period Professor Barton delivered twenty-five courses of lectures on botany, in which he inculcated a high sense of the real *benefits* of the pursuit, in a medical point of view, with an enthusiasm that gave unequivocal evidence of his attachment to the interests of the science and the honour of the university. Such was the success of these efforts, that during the period when the laws of the university rendered it obligatory upon the candidates for its honours, to print their inaugural theses, not one commencement was held without a number of dissertations being published, detailing experiments on the medicinal properties and effects of indigenous vegetables; most of them undertaken at the instance, and prosecuted under the auspices of the Professor. The authors of these tracts were scattered annually through different sections of the United States; many of them cherished the love for botanic pursuits which they had imbibed here—they became botanists—and thus have the exertions of the Professor been seen and felt beyond the precincts of the university. In addition to these facts, it may be mentioned, that many years ago Dr. Barton successfully applied himself to the production of an elementary work on the principles of botany, of acknowledged excellence." Of this I shall speak again when I enumerate the publications Dr. Barton gave to the world.

About five years after Dr. Barton was appointed professor of natural history and botany, viz. at the close of the year 1795, Dr. Samuel Powell Griffiths, who is still living, and a respectable practitioner of medicine of the society of Friends in this city, intimated his intention of resigning the professorship of materia medica in the university, some time in the course of the winter. Dr. Barton became a candidate for it. On this occasion his friend and relative Dr. Rittenhouse, warmly interested himself in the doctor's behalf. In a letter which he addressed to Dr. M'Kean, then chief justice of Pennsylvania, and an eminent member of the board of trustees of the university, he expressed himself in these terms, respecting his nephew—terms of high eulogium from such a man as Rittenhouse, and one who was alike scrupulously sincere, and incapable of flattery: "He certainly has ability sufficient," says Mr. Rittenhouse, "to enable him to be useful in any branch of medicine, and ambition enough to induce him to make the greatest exertion; besides, the materia medica seems so nearly connected with botany and natural history, his favourite studies, that I flatter myself he will be successful in his intended application," &c.*

To this chair of materia medica Dr. Barton was shortly after appointed, being then but just turned of thirty years of age, and having

* Barton's Memoirs of Rittenhouse, page 436.

been professor of natural history and botany near six years. And here, gentlemen, *begins* and *rests* the high professional reputation of Dr. Barton in medicine. To the important lectures on this subject, continued by him till the period when the loss of one of the great pillars of this medical school afforded him an opportunity of a translation to the vacant chair of the practice of physic, is entirely attributable the present conspicuous elevation of the materia medica professorship in this university. Those who have attended the lectures of the late professor on this point of medical science, can bear honourable and powerful testimony in favour of their importance, their learning, their usefulness; and it is no small circumstance in favour of the exertions of his successor in this chair, that we hear nothing of its reputation being in any degree deteriorated, although the present incumbent succeeded to it under circumstances of a very discouraging, nay, almost overwhelming nature.

In chronological order it now becomes proper to digress from the subject, and mention that in the year 1797, Dr. Barton married a daughter of Mr. Edward Pennington, long since deceased, but for many years an eminent and respectable citizen of Philadelphia. This lady, together with the only children, a son and a daughter,* survive their husband and father. A year after this event, viz. on the 28th of January, 1798, he was appointed to succeed Dr. Kuhn, as one of the physicians of the Pennsylvania Hospital, which he continued to hold till his death.

I have just hinted that Dr. Barton was translated from the chair of materia medica to the practical chair, relative to which it is necessary to make a few remarks. From the preceding sketch of Dr. Barton's character, you will not be long in concluding that he was a man of high ambition. The fact is so. He possessed this passion in relation to matters of literary reputaion and science, in a most exalted degree. He had long viewed the splendour of professor Rush's deserved elevation in the paths of medical science, with emotions that could not but stimulate him to more vigorous and continued exertions to equal his fame. Let me add too, whatever may be thought generally to the contrary, he did that great man ample justice in his unreserved conversations respecting his literary and medical career.

Can it then be deemed unnatural, and will you not expect to hear, that upon the death of professor Rush, Dr. Barton became desirous of filling his chair? He accordingly applied for it, and was appointed some few months after the decease of his learned predecessor. This chair he held in conjunction with that of natural history and botany, till the day of his death. It was, however, his intention, had he lived, to resign the latter, perhaps about this time. He believed that the duties of a lecturer on natural history and botany required all the fire, the zeal, the bodily and laborious exertions of a young man. The energy

* The only Survivor of these is Dr. Barton's son Thomas Pennant Barton, Esq. late American Charge des Affairs at Paris, July—1836.

and fervour he had once shown in teaching those branches, he believed himself no longer capable of, neither did he wish to substitute for the necessary perambulatory excursions with his botanical class which had been always frequent) the tame and uninstructive lectures of an old, and, what is an inevitable consequence, of a closet teacher.—He well knew that demonstrative branches, like those of natural history, could neither be faithfully taught nor properly elucidated by a man whose age naturally made him prone to the more inactive pursuits of life. He had been eminent as a teacher of those sciences, because he was young and active—when he became older he was unwilling to detract from his well-earned reputation. Besides these motives, he had determined to devote the remainder of his life to the more important chair to which he had succeeded. In a conversation with me a short time after his accession to the practical chair, in which he stated his intention to keep that of natural history and botany but a year or two longer, he declared his firm determination to direct the concentrated powers of his mind to the fulfilment of the duties of his new professorship; and in his dedication of his Archæologiæ Americanæ Telluris, &c., to Mr. John Mason Good, an eminent surgeon of London, with whom he had long been in habits of correspondence, he thus expresses himself: "It is my object to collect materials for a history of these extinct animals and vegetables, the remains or impressions of which are daily discovered in the rapid progress of American population and improvement. I can hardly flatter myself that my time, devoted as it *must* be to other, and to me more important pursuits, will ever permit me to prosecute these archæological inquiries very far;" and in the preface of the same work he says, "I at one time, indeed, for some years together, flattered myself that I should have found leisure to have devoted a considerable portion of my life to the study of organic geology. But my recent removal, in consequence of the death of Dr. Benjamin Rush, to a more practical chair in the university of Pennsylvania, and a determination to devote a principal portion of the remainder of my days to the cultivation of *practical medicine*, now teach me that it is too late to attempt any very extensive and especially very *systematic* views of these among the most difficult portions of natural history.

These declarations were an earnest of that assiduous application to the duties of his new chair which he certainly paid, with, to him, a fatal degree of faithfulness and labour. His constitution had been worn down by reiterated fits of irregular gout; and a recent as well as severe attack of hæmoptisis, had left him even but a remnant of that trembling and precarious health which for years before had been his companion. As no sickness could tame the vivid flashes of his mind, ever active, restless, and engaged, his hours of pain were continually aggravated by an attention to his studies and the duties of his chair. Nature was not equal to the task imposed on her. And as she ever returns in sickness and in disease the hours which are purloined by

active minds, from her customary and necessary rest, Dr. Barton soon perceived the pernicious consequences of his midnight and injudicious toils. That his efforts to support the reputation of the university curtailed his existence I firmly believe. He had delivered but two courses of lectures in the practical chair, when his increasing ill health forced him to have recourse to the last resort to renovate his constitution: I mean a sea voyage. He accordingly embarked for France in the month of April 1815, and returned by the way of England in November following, not benefitted by his too hasty travel and return.

In the month of February, 1809, Dr. Barton was elected president of this society, Dr. Rush having resigned that station some short time before. This circumstance was a subject of gratification to our deceased associate, as it evidenced the highest respect for his professional standing that it was in your power to bestow. He felt the interest of this society much at heart; and if he did not give demonstrations of this by his frequent attendance, that circumstance should be attributed to his precarious health, his numerous literary avocations and engagements, and his anxiety to finish some works, the completion of which he was very desirous to accomplish. He has left you, gentlemen. No longer will his exertions be made for your interests—for science—for the honour of his country. Let your remembrance of these be perennial, or I should rather say co-existent with your lives—for he justly deserves to be held in long, tenacious, and respectful recollection.

You have chosen, as his successor, one of your late vice-presidents, who has given you frequent evidences of his attachment to your interests, and his zeal in promoting your prosperity. I feel much confidence in congratulating you on this choice, for I am persuaded it has fallen on a friend to young men, and one ever ready to lend his aid to the advancement of their interests and their pursuits.

The primary disease of doctor Barton was unquestionably hereditary gout, of an irregular form, which assailed him in very early life, having had, as I have before mentioned, some violent athritic symptoms while a student at Edinburgh. About three years ago he was attacked, during the night, with violent hæmoptisis. The discharge of blood was copious, and attended with considerable pain in the breast. This alarming symptom, indicating the approach of a more serious disorder, appearing in a constitution feeble, enervated, and worn down by study and the gout, could not fail of producing anticipations of a fatal consequence in the mind of a physician. Accordingly, Dr. Barton dated his approaching death from this event. His prediction was subsequently verified: for certain it is he never after enjoyed even the scanty portion of health that had before been his lot. He had afterwards other attacks of spitting of blood, and for a long time purulent expectoration, cough, and even hectic flushes occasionally; insomuch that he was inclined himself to believe, and his friends who heard his complaints, and witnessed their effects, believed—that a pulmonary affection had at length supervened. It was in this state of health that

he devoted his labours to the writing and preparation necessary to fit himself for the new chair he had been appointed to; and, as I have before hinted, these labours doubtless accelerated his death. It was also in this state of health, after more serious indisposition, during the preceding winter, that he embarked last spring for Europe, with how little real benefit, or even melioration of his malady, I have already stated. Previous to his departure he had many symptoms of hydrothorax, and this disease, in fact, proved the immediate cause of his death. After his arrival at New York he was violently affected with the distressing symptoms of this disease, and his life for three weeks was despaired of. He was spared however to reach his home in this city, and after a protraction of this indulgence of Heaven long enough to receive the visits of all his relations and friends, near to him, as well as of most of his medical brethren of this city, he expired suddenly in the bosom of his family on the morning of the nineteenth day of December last. He was in fact found dead in his bed. His wife, three hours before, had seen him unusually tranquil in his sleep. He seemed to have a strong presentiment of his approaching dissolution on the evening preceding his decease: for he requested, contrary to his usual custom, that his physician, professor Wistar, should not be admitted to him that night, and refused to have the friction of his legs continued, intimating by his manner his conviction that neither medical advice, nor any remedies, could any longer be of service to him. He possessed his mental faculties, if not wholly unimpaired, at least unusually active and correct, till the last moment that he spoke. Three days before his death he wrote a memoir on a new genus of plants, named in honour of him, and requested me to make a drawing of one of the species to accompany it. This I did, and at the next meeting of the Philosophical Society, I read this memoir for him. It will of course make its appearance in the next printed volume of that society's transactions, and must always be viewed as a memento of his wonderful activity of mind, which continued its operations for the elucidation of science even to the last day or two of his life--and this too in the midst of disease, of pain, and of sorrow.

The following letter from his physician, Dr. Wistar, received this morning, will give you a more particular account of his last illness:

"Dear Sir,

"Your uncle was affected with the ordinary symptoms of hydrothorax. I believe the disease commenced before he left this country. From his account it appeared to be mitigated during his voyage to France, and while he resided in that country, but increased a short time before he left England. There was a continued succession of storms during the homeward voyage, and he soon became so ill that he could not bear the recumbent posture, and therefore did not lie down during almost the whole of the time he was on board the ship. His sufferings were such that he wished for death. He used the dried

squill as a diuretic, during the voyage, but it did not produce the desired effect. After he landed, a greater diuresis was effected, and he was considerably relieved. His death, although not expected at the time when it occurred, was similar to what I have known in at least half a dozen instances of hydrothorax. One of my patients died within five minutes after her return from riding. Another died as he was walking in a wood. Dr. Kuhn, the elder, was found dead in his chair. The late Mr. Milnor, of Trenton, I have been informed, died at his desk. "I am very respectfully yours,

"C. WISTAR.

"*Thursday Feb.* 15*th*, 1816."

Such was the event that has bereaved the cause of American science of its ablest, its truest, and its most substantial advocate—its most *substantial*, for reasons I shall now state. Dr. Barton, in the commencement of his career, was not only indigent, but oppressed. He continued his exertions, however, undismayed by poverty, and unintimidated by enemies. And to those who know more intimately than it would be proper to state in this memoir, the struggles he made in early life through the most discouraging, nay appalling influence of want, added to the direful ravages of disease,—his subsequent elevation appears astonishing. His public lectures, and his various works, the rich harvest of his meritorious exertions, soon relieved him from the pressure of indigence, and the mental uneasiness, nay, sometimes distraction, that supervenes upon it. He whose mental exertions survive such a fate, and who perseveres through it, is not, believe me, a common man!

Among the first objects of his attention, when he obtained the means of realizing it, was exploring the extensive wilds of our country, to cull the rich and unknown treasures, particularly among the vegetable productions, which he believed were there; and to obtain information respecting every curious and useful subject of natural history, that invited the attention of the naturalist. Unable, from his professional engagements, to travel himself, and search out these curious spoils, he employed the talents of others, whom taste may have qualified, while their circumstances incapacitated them for such pursuits. To these he afforded, liberally, the requisite funds, and necessary information. The only remuneration Dr. Barton received for these unequivocal demonstrations of his love for science, were the acquisition to himself and others, of useful and novel information, and the thanks and acknowledgments of those who were the subjects of his liberality.*

* In proof of the above remarks, I may here not unappropriately cite from the late valuable publication of Mr. Pursh, on our American plants, the following passage, alike honourable to the memory of Dr. Barton, and to the good feelings of Mr. Pursh:

"Within this period [between 1802 and 1805] I had also formed a connexion with Dr. Benjamin Smith Barton, professor of botany, &c. in the university

Thus gentlemen have I endeavoured to point out some of the more prominent of the numerous exertions made by your late president, in the cause of American science. The advantages that have resulted to its interest, by such substantial countenance, fully appear in the valuable work of Mr. Pursh, which contains the united discoveries of this gentleman and Mr. Nuttall.

of Pennsylvania, &c. whose industrious researches in all the different branches of natural history are so well known to the literary world. He likewise, for some time previous, had been collecting specimens for an American flora. As I was now very anxious to explore the remote parts of the country, particularly the interesting ranges of the Allegany mountains, I was enabled by the kind assistance of this gentleman, to take a more extensive range for my botanical excursions, which, during my stay at the Woodlands, had been confined within a comparatively small compass, the necessary attention to the duties of that establishment not permitting me to devote more time to them. Accordingly, in the beginning of 1805, I set out for the mountains and western territories of the southern states, beginning at Maryland and extending to the Carolinas (in which tract the interesting high mountains of Virginia and Carolina took my particular attention) and returned late in the autumn through the lower countries, along the sea-coast to Philadelphia."—***Flora Americæ Septentrionalis**, by **Frederick Pursh**, **London**, **pref. p.*** ix.

I have made this full quotation, that every one may see for himself the extent of country over which Mr. Pursh travelled at the expense of his patron and employer.

Dr. Barton also extended his assistance to a young English botanist, a Mr. Nuttall, " whose zeal and services," to use the words of Dr. Barton, " have contributed essentially to extend our knowledge of the north-western and western flora of North America; and to whom the work of Frederick Pursh is under infinite obligations."—In justice to Mr. Pursh I beg leave to state, that for the assistance so received, he gives Mr. Nuttall all due credit, although there appears to be some little disagreement between them, respecting the discovery of a new genus of plants, called Bartonia by their joint consent, in honour of, to use Mr. Pursh's words, " their mutual friend, Dr. B. S. Barton." Respecting Mr. Nuttall, I beg leave to quote from a manuscript paper now in my possession, written by Dr. Barton three or four days before his death, the following observations:

" I became acquainted with this young Englishman in Philadelphia several years ago; and observing in him an ardent attachment to, and some knowledge of botany, I omitted no opportunity of fostering his zeal, and of endeavouring to extend his knowledge. He had constant access to my house, and the benefit of my botanical books.

" In 1810 I proposed to Mr. Nuttall the undertaking of an expedition entirely at my own expense, and under my immediate direction, to explore the botany, &c. of the northern and the north-western parts of the United States, and the adjoining British territories. Accordingly, having provided him with a *special* passport from the president of the United States, Mr. Madison, and with whatever else I deemed necessary, together with a considerable collection of manuscript queries and memoranda, Mr. Nuttall took his departure from Philadelphia in April, 1810.

With a view still farther to elucidate this point, and to give you, in the fairest way possible, such an history of his improvements in science, as your resolution appointing me to perform this duty, requires —I shall beg your patience for a short time, while I briefly enumerate his various works, their titles, and their extent, by affixing the number of pages in each. Such a catalogue will not only enable each of you to make your own deduction on the subject, but it may perhaps, be a mean of giving you some useful information respecting the number, the nature and extent of Dr. Barton's works—some of which are, in this country, as yet unknown. They are, so far as I can collect them as follow:

1. De Hyoscyamo nigro—the Harveyan prize dissertation, before mentioned, 1787. (I am doubtful if this is printed.)
2. On some parts of natural history, &c. &c. his first work, before mentioned, published in London in 1787—octavo, about 80 pages with an engraving.
3. A memoir concerning the fascinating faculty which has been as-

" His route was by Pittsburg to Detroit, Michilimakinak, Fox River, the Falls of St. Anthony, &c. He deviated, however, from the route which had been pointed out to him, having been prevailed upon to ascend the Missouri in company with some of his own countrymen, some Americans, and others, whose objects were principally traffic.

" He proceeded to the Mikanee-town; from thence to the territory of the Mandan Indians, in the boat of a Spanish gentleman; and in the same vessel descended the Missouri to St. Louis, near the confluence of this great river with the Mississippi, in the autumn of 1811.

" Among a very considerable number of plants which he observed and collected, in the course of his journey, there were two species of a genus which he observes in his notes to have the " facies" or aspect of cactus, and which he very properly referred to the class and order of *icosandria monogynia*—he named this genus Bartonia. One of the species he calls Bartonia superba, and the other Bartonia polypetala. The former he found in flower in August and September; growing all the way from the river Platte to the Andes, on broken hills and the clefts of rocks—(Pursh adds, not I fear on the best authority, 'and on volcanic soil.') He speaks of it as a plant (herba) about three feet high, whose 'splendid flower expands only in the evening, suddenly opening after remaining closed during the day, and diffusing a most agreeable odour. It may justly rank, (he adds) with the most splendid plants of either America, and very probably inhabits Mexico, if not South America.

" The other species, Bartonia polypetala, he describes as a perennial, growing on gravelly hills, near the Grand Detour, and flowering in August.

" In the latter end of the year 1811, Mr. Nuttall returned to England by the way of New Orleans. Previously to his departure, he transmitted to me a number of the dried specimens and seeds which he had collected. Among these there were specimens of both species of Bartonia, together with a good collection of seeds. At the same time, he sent me a manuscript book, in which he has given pretty full descriptions of the two plants by the names which I have already mentioned: viz. Bartonia superba and Bartonia polypetala."

cribed to the rattlesnake and other North American serpents; first edition, octavo, 36 pages—1796.

4. Collections for an essay towards a materia medica of the United States. Read before the Philadelphia Medical Society on the twenty-first day of February 1798—49 pages, octavo.
5. Fragments of the natural history of Pennsylvania, folio, 42 pages —1799.
6. New views of the origin of the tribes and nations of America—octavo, 165 pages—1798.
7. Supplement to a memoir concerning the fascinating faculty which has been ascribed to the rattlesnake and other North American serpents, in a letter to professor Zimmerman of Brunswick, in Germany—octavo, 38 pages, 1800.
8. Memoir concerning the disease of Goitre, as it prevails in different parts of North America; octavo, 94 pages, 1800.
9. Collections, &c. part first, second edition—64 pages, octavo—1801.
10. Elements of botany, or, outlines of the natural history of vegetables, illustrated by 30 plates, first edition, two volumes octavo, together 508 pages—1803.
11. Collections, &c. part second, first edition, 53 pages octavo—1804.
12. Facts, observations, and conjectures relative to the generation of the opossum of North America, in a letter to Mons. Roume of Paris 8vo. 14 pages, 1809.
13. A discourse on some of the principal desiderata in natural history and on the best means of promoting the study of this science in the United States; read before the Philadelphia Linnean Society, on the 10th of June 1807—octavo, 90 pages—1807.
14. Some account of the Siren Lacertina, and other species of the same genus of amphibious animals; in a letter to Mr. John Gottlob Schneider of Saxony, with an outline engraving of the animal, from a finished drawing made by myself. Octavo, 34 pages, 1808.
15. Collections, &c. 3d edition, octavo, 120 pages; 1810.
16. A memoir concerning an animal of the class of reptilia, or amphibia, which is known in the United States by the names of alligator and hell-bender, with an engraving; octavo, 26 pages—1812.
17. Flora Virginica: sive plantarum, præcipue indigenarum, Virginiæ Historia inchoata. Iconibus illustrata.* Pars prima, octavo, 74 pages. Printed in 1812, and going only as far as the fourth class of the Linnæan arrangement. This work has never yet been published in this country, though I have some reason for believing Dr. Barton took it with him in his last voyage to Europe. It is nothing more than an enlarged and new modified edition of the Flora Virginica of Clayton and Gronovius, with the addition of the specific names under which the plants enumerated are described by Michaux, Willdenow, Persoon, &c.

* There are no plates in it

18. Elements of Botany, or outlines of the natural history of vegetables, illustrated with forty plates; the second edition, first volume. 310 pages, with an index of forty pages—1812.
19. Additional facts, observations, and conjectures, relative to the generation of the opossum of North America, in a letter to professor J. A. H. Reimarus of Hamburg, octavo, 24 pages—1813.
20. Archæologiæ Americanæ Telluris Collectanea et Specimina; or collections, with specimens, for a series of memoirs on certain extinct animals and vegetables of North America; together with facts and conjectures relative to the ancient condition of the lands and waters of the continent; illustrated by engravings.* Part first, octavo, 64 pages—1814.
21. Elements of Botany, second volume, in 1814.
22. Memoir concerning the fascinating faculty which has been ascribed to various species of serpents; a new edition, greatly enlarged and embellished by a plate; quarto, 76 pages—1814.
23. An edition of Cullen's Materia Medica, with notes.
24. Ditto first vol. Cullen's First Lines.
25. Medical and Physical Journal.

Besides these separate works, the following is a list of his papers and memoirs, read to the American Philosophical Society and printed in the different volumes of the transactions of that society.

1. An account of the most effectual means of preventing the deleterious consequences of the bite of the crotalus horridus, or rattle-snake. Philo. Trans. vol. 3d, pages 14, quarto.
2. An inquiry into the question whether the apis melifica, or true honey-bee, is a native of America. Ditto, 20 pages quarto.
3. A botanical description of the podophyllum diphyllum of Linnæus, in a letter to Charles Peter Thunberg, M. D. Knight of the Order of Wasa, Professor of Medicine and Botany in the University of Upsal, &c. Ditto, 14 pages quarto, accompanied with a plate of the plant to which Dr. Barton gave the name of Jeffersonia, in honour of Thomas Jefferson.
4. An account of the fascinating faculty which has been ascribed to the rattle-snake and other North American serpents. Vol. 4th of the Philo. Trans. 40 pages quarto. (This paper afterwards appeared in the form of a separate work, as has been mentioned, and went through two editions.)
5. Some account of an American species of dipus or jerboa. Ditto, with an engraving of the animal. 11 pages quarto.
6. Observations and conjectures concerning certain articles which were taken out of an ancient tumulus or grave, at Cincinnati, in the county of Hamilton, and territory of the United States, north-west of the Ohio; in a letter to Dr. Priestley. Ditto, 36 pages quarto.
7. Hints relative to the stimulant effects of camphor upon vegetables. Ditto, 3 pages quarto.

* The work has no Plates.

8 Some account of the poisonous and injurious honey of North America. Vol. 5. Phil. Trans. 16 pages quarto.

9. Memorandum concerning a new vegetable muscipula. Vol. 6, Phil. Trans. 3 pages quarto.

10. Some account of a new species of North American lizard—Ditto, 5 pages quarto, with an engraving of the animal.

11. Supplement to the account of the dipus Americana, in the 4th vol. of the transactions of the Am. Ph. Society. Ditto, 2 pages quarto.

12. Hints on the etymology of certain English words, and on their affinity to words in the languages of different European, Asiatic and American (Indian) nations, in a letter to Dr. Thomas Beddoes. Ditto, 13 pages.

Besides these there are other papers which will appear in the next volume of the society's transactions, and which have been read some years: viz.

13. At a special meeting of the Philosophical Society, Feb. 24, 1804, Dr. Barton was chosen to deliver an eulogium upon Dr. Priestley. This was a very learned and extensive memoir—it is not yet published, though I suspect it remains among his manuscripts in a state for publication.

14. In February 1800, he read to the Am. Phil. Society an extensive memoir, entitled, "A geographical view of the trees and shrubs of North America"—not yet published.

15. And a memoir (which gained the Magellanic premium) concerning a considerable number of pernicious insects of the United States, which will appear in the next volume of the society's transactions. (These two last papers are mentioned by Dr. Barton in his discourse on the desiderata in natural history, &c.) and it is from that circumstance that I here enumerate them.

Professor Zimmerman translated into German, the memoir (Transactions Phil. Society) on the bite of the rattle-snake. Also the memoir on the fascinating faculty of the rattle-snake, &c. to which last he added notes, and an introduction in the German language of 22 pages duodecimo.

The Elements of Botany have been republished in London, and translated into the Russian language at St. Petersburgh.

These, gentlemen, are all the works which have been printed by Dr. Barton. Some of them have never yet been published, and many of them were designed entirely for the inspection and perusal of his numerous European correspondents. As it may be supposed, these works obtained for him great notoriety in Europe where he is honoured and respected.* Besides them Dr. Barton republished the letter of John

* It may not be amiss to enumerate the foreign academic honours which Dr. Barton received at different periods of his life. I have it not in my power, however, to do this in chronological order, since I have not at this time access to any materials that will enable me to do so. He was a member of the Imperial Society of Naturalists, at Moscow in Russia; one of the foreign members

Henry Burkhard, to Leibnitz, written in the Latin language. He had written a Latin preface to this republication, which I have perused in manuscript and also in a proof-sheet. At the time I saw them, it was the intention of Dr. Barton to circulate it with the preface, among the botanical students. By inspection of the work which has now fallen into my hands, I find the preface is omitted, and the letter appears in its original form without comment. For the cause of this omission, with which I confess myself somewhat astonished, it is not difficult for me to account. On some future and more appropriate occasion, I shall endeavour to explain the history of this remarkable attempt to wrest from Linnæus, his long accredited claim to originality in the principles of his sexual system.

The ardent thirst for literary fame, which strongly marked the character of Professor Barton through life, rendered him a most indefatigable student from his earliest youth. He read much, wrote a great deal, and contemplated nature with unceasing attention. His numerous publications afford, of themselves, sufficient proofs of an uncommon degree of industry: but besides these, he was long engaged in collecting materials for other works, and preparing some for the press; all of which it is greatly to be regretted, will now probably be lost to the world.

Amidst his professional avocations, which were numerous--the duties of his station, as a medical teacher, which were arduous—and a considerable portion of his time that was occupied in keeping up an epistolary correspondence with distinguished men of science,* as well in the old world as in his own country—amidst all these occupations, it is a matter of surprise, that he could have found a sufficiency of leisure for his multitudinous pursuits in literature and science: and the more especially when it is taken into view, that he was frequently impeded in these pursuits by the privation of health.

of the Linnæan Society of London; correspondent member of the Society of Antiquaries of Scotland; member of the Danish Royal Society of Sciences at Copenhagen; and also member of the Royal Danish Medical Society at Copenhagen. Of this last named academy he was a member several years ago, at the same time with the late Professor Rush. The diploma from this society, however, Dr. Barton received only a week or two before his death, by Mr. Pederson, minister from the king of Denmark to the United States.

* Among the most distinguished of these are the following named:

The count de la Cépède, peer of France, &c. to whom Dr. Barton dedicated the quarto edition of his memoir on the fascinating faculty of the rattle-snake.

Professor E. A. W. Zimmerman, of Brunswick, in Germany.

Professor J. A. H. Reimarus, of Hamburg.

Professor John Frederick Blumenbach, of Gottingen, to whom he dedicated his memoir on the disease of Goitre.

Mr. Thomas Pennant, the celebrated author of Arctic Zoology.

John Mason Good, Esq. F. R. S. &c. surgeon, of London, (well known by his poetical version of the Songs of Solomon)—to whom he dedicated his Archæologiæ Americanæ Telluris, &c.

Natural history and botany were his favourite studies,* and in his investigation of these branches of science, he made a conspicuous figure. He employed much research, respecting the origin of the tribes and nations of America, on which subject he has, I am persuaded, left many valuable manuscript materials. He was fond of investigating what may be termed the *antiquities* of this country; and particulary interested in zoological inquiries.

He was a skeptic in matters of science, depending on human testimony—in fact, his incredulity was astonishing. He upheld the value of skepticism in his lectures—and in one of his publications he thus expresses himself: "Credulity is the most injurious feature in the character of the naturalist, as well as of the historian. Its influence, in one individual, is often felt and propagated through many ages. Un-

Dr. James Edward Smith, the learned president of the Linnæan Society of London, to whom he dedicated the second edition of the first part of his Collections, &c.
Professor Autenrieth, of Tubingen.
Mr. Tilesius, an eminent naturalist of St. Petersburgh, Russia.
Monsieur Roume, of Paris, an intelligent French naturalist.
Mr. John Gottlob Schneider, of Saxony, a late celebrated writer on amphibious animals.
Dr. Patterson, of Londonderry, in Ireland.
Monsieur G. Cuvier, of Paris, the illustrious author of many learned works on organic geology, &c.
Sir Joseph Banks, Bart. the well known liberal and munificent patron of literature and science.
Dr. John Walker, professor of natural history in the University of Edinburgh.
Baron Humboldt.
Professor Pallas, of Russia.
Professor Sparrman, Sweden.
Professor Thunberg, Sweden.
Professor Burmann, of Holland.

* In the preface to his Elements of Botany he thus speaks of his attachment to these sciences: "The different branches of natural history, particularly zoology and botany, have been my favourite studies from a very early period of my life. The happiest hours of near sixteen years of cares, of difficulties, or of sickness, have been devoted to the cultivation of these interesting sciences. During this long period, I have never ceased to look forward, as I still look forward, with an ardent satisfaction, to the time, when natural history (including botany) shall be taught as an indispensable branch of science, in our university. That period, however, has not yet arrived. I have, however, the satisfaction of observing, that these sciences are making some, nay, even great, advances among us; and I still flatter myself, that the directors of our principal American universities, or other seminaries of learning but, *in particular, the trustees of the University of Pennsylvania*, (in which all the branches of medicine are taught much more extensively than in any other part of the United States) will see the *propriety* and even *necessity*, of giving *more substantial encouragement* for the extension of natural history among us."

fortunately, too, it has been the vice of naturalists, or those who have touched on questions relative to natural history."

The genius of Dr. Barton was of the highest grade: it was rapid, comprehensive, and brilliant in the extreme. He was well aware of the inefficacy and fruitlessness however, of its unaided efforts—he did not rely therefore on the native powers of his mind alone, great as they were, but applied himself closely to the avocations of the closet. He was not only a man of extraordinary industry, but of quick perception, and various information. His genius prompted him to conceive with celerity all the varied and diverse relations of those subjects, to which the bent of his mind more particularly attached him—he was therefore, a rapid writer. He possessed a memory remarkably, nay extraordinarily tenacious and faithful, particularly with respect to facts and chronological events. He never forgot what he once determined to remember, hence he read with great advantage; and though his reading was always desultory, irregular, and to all appearance hasty—he was able to make the most profitable use of it. He possessed a good judgment, much imagination, and a taste for the fine arts. He was indeed a man of uncommon genius and excellent professional talents.

As a medical teacher, he was eloquent, instructive, and when occasion called for it, quite pathetic. His voice was good, though attenuated, penetrating, and sometimes rather sharp—his enunciation clear and distinct—his pronunciation constrained, and his emphasis, owing to his remarkable kind of punctuation, and a desire to be perspicuously understood, was studied, forced, and often inappropriate. In his lectures, his diction was cacophonus and unpleasant.

As a writer, he is ingenious, rich in facts, profound in research, and always abounding in useful information. He wanted, however, in a great degree, a talent for generalizing. Hence his various works are characterized by an egregious want of method, or perspicuous arrangement. His style, it must be confessed, is always diffuse, inelegant, and frequently tautological. As he never corrected what he once wrote, or at least but rarely, these defects in his composition were the natural consequences of his vehemence in writing. His punctuation is truly remarkable, and, for a man of his discernment and extensive reading, singularly incorrect.

As a physician, he discovered a mind quick in discriminating disease, skilful in the application of appropriate remedies, though he certainly was a very cautious if not timid practitioner. No man read more extensively on the subject of diseases—in fact he was deeply versed in pathological knowledge, derived from books. As however his medical practice was never very extensive, his practical observations delivered in his lectures were strikingly marked with the evidences of overweening caution. Hence he recommended to his pupils, and always employed himself, unusually small doses of medicine. He was however in the main, an observing and intelligent practitioner, and

was remarkably assiduous in his attentions, and soothing in his behaviour to his patients.

In figure he was tall, and exceedingly well formed; in middle life he might be considered as having been handsome. His physiognomy was strongly expressive of intelligence, and his eye was remarkably fine and penetrating.*

In temperament he was irritable and even choleric. His spirits were irregular, his manners consequently variable, impetuous, vehement. These repeated vacillations between equanimity and depression, were generally owing to the sudden and repeated attacks of his continual earthly companion—irregular gout.

In familiar conversation he was often elegant, remarkably facetious, but never witty.

As a parent, he was kind, tender and indulgent, to a fault.

He possessed some high virtues; among the most elevated of them, was his unaffected love of country. Indeed, his patriotic feelings were not only strong, but frequently expressed with unreserved warmth. He always spoke with extreme impatience of the arrogance of pretending foreigners of the literary grade, too many of whom resort to our country, being nothing in their own, and perpetually insult us by their vain and insufferable denunciations of our claims to national genius, talents and learning.

Such, gentlemen, was the late Professor Barton! May not such a man be truly called great? Before he had completed the fiftieth year of his age, the world was deprived of his talents—his country, more particularly, of his usefulness, and his family of a kind and affectionate protector. While the exit of so ardent a lover of the pursuits of science has given serious occasion to its remaining votaries to deplore his loss, may we not hope that they will emulate his talents and his worth!

* The best likeness extant of Dr. Barton, in the fine profile, done in mezzotinto, by St. Memim (the engraving prefixed to this sketch is copied from it) when the doctor was about thirty-seven years of age. The life-size crayon profile, from which the miniature mezzotinto was taken, is also a very good likeness: it is the property of the Pennsylvania Hospital, where it now is. His portrait of *kit-kat-size*, was painted while in England, by his ingenious friend and early protege, Mr. Jennings: this was, at the time it was taken, a good likeness. And another, in a more finished style of painting, though certainly not a happy resemblance, was painted by Mr. Rembrant Peale, within the last two years of the doctor's life. Mr. Trott painted a fine miniature picture of him, which is in all respects, except the expression of the mouth, a most excellent likeness.

The execrable caricatures now exposed for sale in the print-shops and book-stores, have only the most distant traces of resemblance.

ELEMENTS OF BOTANY.

"Nec dubitamus, multa esse, quæ & nos prætererint. HOMINES ENIM SUMUS & OCCUPATI OFFICIS." C. PLINII SECUNDI, Naturalis Historia, Lib. I.

LINNÆUS* has made a general division of the plant, or vegetable, into three parts, viz. the RADIX, the HERBA, and the FRUCTIFICATIO. Each of these parts I shall notice in succession.

SECTION I.—THE ROOT.

The *Radix*, or Root, is the lower part of the vegetable, which is generally attached to the earth, from which it derives various nutricious principles which it conveys to every part of the plant. It supports the *Herba* and the *Fructificatio*.

The root consists of two parts, which are denominated *Caudex*, from *cædo*, to cut down, and *Radicula*, a *little root*. The caudex is the stock, or main body; the radicula, the stringy or fibrous part, which in the greater number of vegetables, terminates the main root, and is supposed to be that part of the root which is especially concerned in absorbing nourishment from the earth.

The caudex is either descending or ascending. The *caudex descendens*, or descending caudex, strikes gradually downward into the ground, and puts forth radicles, or small fibres, which are generally regarded as the principal and really essential part of every root. The *caudex ascendens*, or ascending caudex, is that part of the root which gradually raises itself above the ground, serving frequently the place of a trunk or stem, and produces the herb. It is the descending caudex only which entirely corresponds to the term radix, or root, as it is employed by other botanists. The term caudex ascendens corresponds, in some measure, to the caudex of Malpighi, and other naturalists, who, following the authority of classical writers, designate by this name, the stem, trunk, or bole of a tree.

The distinction of L. is, at least, ingenious. It is founded upon this fact, that trees and shrubs, when they are inverted, put forth leaves from the descending caudex, or proper root; and radicles, or roots from the ascending caudex, or stem. Accordingly, he considered trees and shrubs "as roots above ground."

* Whenever the name of Linnæus hereafter shall occur in this work, it will be designated by the initial L.

In a philosophical analysis of the vegetable, this may, perhaps, be a just view of the subject: but it is not probable, that his distinction will ever be generally admitted.

I shall treat of the principal roots, under the following: viz. 1. of Roots, in respect to *form*, or *shape:* 2. in respect to their *direction* or *manner of growth:* 3. in respect to their *duration.*

Roots, in respect to their form, or shape, may principally be referred to the following species, viz: 1. *Radix fibrosa:* 2. *Radix fusiformis:* 3. *Radix tuberosa:* 4. *Radix præmorsa:* 5. *Radix granulata;* and 6. *Radix bulbosa.*

1. The R. fibrosa, or fibrous root, consists entirely, or principally, of a number of fibrous radicles, each of which is more slender than the base of the trunk or stem, to which it is attached. The greater number of the *Gramina,* or Grasses, such as the Wheat, the Rye, the Oat, the Barley, the Rice, &c. furnish us with the best examples of this form of root. In the grasses the fibres proceed from a small knot at the base of the stem. This kind of root, consisting of very slender fibres, is sometimes denominated *Radix capillacea,* from *capillus,* a hair; or the hairy root.

The term fibrous root comprehends a very great number of roots, which, as being more slender than the base of the stem or bole, may, with propriety, be arranged under this head. Such are the roots of the greater number of trees and shrubs.

2. The R. fusiformis called in English fusiform or spindle-shaped tap-root, is a species of root, which tapers from above downwards to a point, more or less slender. The radicles, strings, or fibres, are commonly disposed over the whole surface of the stock, or principal root. We have examples of this species of root in the Carrot, the Parsnip, the Hemlock, the Radish, Horse-radish, and many others. Cultivation frequently changes the spindle-shaped root into a round, knobbed, or tuberous root. This has been particularly observed in some of the umbelliferous plants.

3. The R. tuberosa, tuberous or knobbed root, is a hard, solid and fleshy root, which, in general, is thicker than the base of the stem to which it is attached. It consists either of one knob, as in the common Turnip, or of many such knobs collected, by means of a number of slender strings or filaments, into a bunch, as in the Pæony, Sun-flower, Drop-wort, Potatoe, and many others. The radicles are dispersed over every part of the tuberous root; whereas in the roots afterwards to be mentioned, the radicles are entirely confined to the bottom of the root.

Some of the tuberous roots, such as those of the Arum, Orchis, Moschatelline, and others, emit their radicles at the top, from a knot formed between the stem and the thicker part of the root. Such roots have been called *Radices comosæ,* from *coma,* a bush or head of hair, from a fancied resemblance of the fibres to a bunch of hair.

4. The R. præmorsa does not taper, but ends (abruptly) blunt, and

thus appears as though it were bitten off short at the end. Hence, perhaps, it might be called the bitten root. The Scabiosa, or Scabious, the Plantago, or Plantain, the Valeriana, or Valerian, furnish us with examples.

5. The R. granulata, or granulate root, consists of several little tubers, or fleshy knobs, which somewhat resemble grains of corn. The Saxifraga granulata, or White Saxifrage, exhibits the best example.

6. The R. bulbosa, or bulbous root. This form is, more properly speaking, a large bud, situated under ground. It encloses and protects the future plant, several generations of which lie enveloped in it, until they are unfolded by the action of water, or other fit alimentary stimulus. L. calls this part, as he also does the true buds of trees and shrubs, the *Hybernaculum*, or winter-quarters of the plant. He does not consider the bulbus as a species of root.

The bulbus consists of two parts, viz. the bulbus, properly so called, and the radicula, or radicle. This last is considered the true root, or fibrous appendage, arising from the lower part of the bulb, by which it is attached to the earth, in which it grows. These radicles may be considered as so many absorbing vessels, by which the various alimentary matters of the plant are conveyed, through the bulb, to every part of the plant. Experiments, however, show that the radicles, or cylindrical fibres, of certain bulbous rooted plants, such as the Hyacinth, are by no means necessary to the full growth and perfection of these plants. This has been proved by the Marquis de S. Simon, in his work on *Hyacinths*. He considers radicles rather as exhaling, than as absorbing organs; and asserts, that it is the middle part of the bulb which is endued with the absorbing power.

There are four different kinds of bulbs: 1. *Bulbus squamosus:* 2. *B. solidus:* 3. *B. tunicatus:* 4. *B. articulatus.*

The b. squamosus, squamose or scaly bulb, consists of a number of imbricated lamellæ, or scales. Different species of Lilies furnish us with examples.

The b. solidus, or solid bulb, consists of one solid and fleshy substance. The Tulip is given by L. as an instance. I cannot consider the bulb of the Tulip as a solid bulb. Carefully examined, it evidently appears to be a true coated bulb. Professor Ludwig has adduced the common Crocus, or Saffron, as an example. But even this, upon minute examination, appears to consist of a number of tunics, or coats, the exterior of which spontaneously separate from one another; and the internal ones, though thicker, may, with ease, be separated. Indeed, some writers have doubted, whether a true solid bulb, in the Linæan sense of the word, does exist.

The b. tunicatus, the tunicated or coated bulb, consists of a number of tunics, or coats, which are regularly laid over each other. The common Onion, the Amaryllis, and many other plants, furnish instances of this species. The coats of this kind of bulb are sometimes so very thick and succulent, that they are sufficient to make the plant vegetate,

without the aid of earth or water. Thus, we often observe the officinal Squill, as it lies in the shops of the apothecaries, protruding both vigorous stems and flowers.

The b. articulatus, the articulated or jointed bulb, consists of lamellæ, that are linked or chained together, as in the Lathræa Squamaria, or Tooth-wort, the Adoxa Moschatellina, or Tuberous Moschatel, and the Martynia.

L. mentions a *Bulbus duplicatus*. This name is applied to certain roots, which have two bulbs connected together. Some species of *Orchides* furnish us with the best examples. Such is the Ophrys, which is called, in some parts of the United States, by the ridiculous name of "Adam and Eve." Where two bulbs are thus united together, it is commonly observed, that one of them is light, empty, and swims upon the surface of the water; whilst the other, which is solid, sinks by reason of its weight. From the former, the plant of the present year has proceeded, whilst the latter contains the bud of the future year. (Plates II. and III.)

L. does not consider as a true root any of the species of bulb. He views them as large buds situated under ground, protecting the embryo from the severity of the winter, and from other injurious causes. That the bulb does, like a true bud, actually enclose the tender embryo, I shall not attempt to deny. Yet I believe it would have been difficult for L. to have *demonstrated* the pre-existence of the embryo, in all the different species of bulb. Who has seen the embryo, in some of the articulated bulbs? It must exist there, it will be answered, because the bulb shoots into a new plant, in every essential respect similar to the parent plant. Then the leaf of the Aloe, the leaf of the Orange, and the leaves of many other plants, are bulbs, or buds, for they when committed to the ground, produce new plants, similar to their parents.—But I cannot convince myself, that this is a sufficient reason for asserting, that the bulb is not, in reality, a species of root. He considers the tuber, or knob, of the Patatoe, however, as a true root: yet this tuber, as well as the bulbus, in the Linnæan sense of the word, encloses and protects the tender embryo. L. informs us, that in the hollow stem of the Osniunda, near its root, is contained the embryo-plant that is to be born the following year. Why does he not consider this "caulis cavus," or hollow stem, as a true hybernaculum, or bulb, or bud? Besides, the observations of the Marquis de S. Simon, compel us to entertain doubts concerning some of L.'s notions respecting the bulb. He says, the radicles, or small fibres, which are attached to the bulb, are the only part entitled to the name of a true root. But it appears highly probable, that all these fibres do not act the part of absorbing organs, or vessels; some of them, at least, appear to be exhalents. Certain it is, that the radicles are not necessary to the nutriment of the plant through the medium of the bulb. Some of the most vigorous blossoms are often protruded from bulbs, the radicles of which have fallen off, almost immediately after their appearance.

In the study of plants, it is a matter of essential importance to attend to the structure of the bulb, or bulbous root. These bulbs frequently afford excellent marks for distinguishing one species of plant from another of the same genus. Thus, the different species of the genus Scilla, or Squill, can hardly be distinguished from each other, except by the circumstance of their bulbs, which are coated, solid and scaly.

The *Bulbus caulinus*, or stem-bulb, and other similar productions, which, both in their structure and office, are very nearly allied to the bulb of which I have already treated, I shall consider under the head of Hybernaculum.

Plants that are furnished with bulbs, or bulbous roots, have received the name af *Bulbosæ*, or Bulbous plants. They constitute one of the classes in the method of Andreas Cæsalpinus. *Bulbosæ* and *Bulbosis affines* are the names of the twenty-fourth and twenty-fifth classes in the *Methodus Propria* of Mr. Ray. L.'s ninth and tenth orders, *Spathaceæ*, and *Coronariæ*, in his attempt towards a natural method, embrace many of the finest vegetables that are furnished with bulbous roots. Such, for example, are the Hæmanthus, Amaryllis, Pancratium, Narcissus, Galanthus, Crinum, Colchicum, Allium, Polianthes, Ornithogalum, Scilla, Hyacinthus, Hypoxis, Lilium, and Tulipa.

Roots, with respect to their direction, or manner of growth, are very different from one another. Some are perpendicular, or run directly downwards into the earth. These constitute what L. calls the *Radix perpendicularis*, or perpendicular root. This term is generally applied to a particular kind of root, which descends, in one straight fibre, that gradually tapers from above downwards, and whose greatest diameter does not exceed that of the base of the stem. The Carrot, Parsnip, and other spindle-shaped roots, are also examples of the perpendicular root. Some of the perpendicular roots strike but a little way into the ground, such as the Datura, or Thorn-apple; some pierce deep, as the Horse-radish, the Phytolacca, or Poke, and others.

The *Radix horizontalis*, or horizontal root, extends itself under the surface of the ground, nearly in a horizontal direction. The Iris, the May-apple, the Hop, the Cinquefoil, furnish us with examples of this direction of the root. Some of the horizontal roots run very near to the surface of the earth; such as the Woodbine and the wild Anemone; others run lower down, as the Triticum repens, or Couch-grass. The horizontal root is sometimes called level or transverse-root. According to the greater or less severity of the climate, the perpendicular and horizontal roots (of the same species) will often be found to pierce the earth more or less remote from its surface. The root, as well as every other part of the plant, accommodates itself, in some measure, to the climate in which it grows.

The R. repens, or creeping root, is, by L. distinguished from the horizontal root, to which, however, it is nearly allied. While the lat-

ter is extended under the earth, in a transverse direction, the former is observed to creep horizontally, in every direction, putting forth fibres as it proceeds. The Mentha, or Mint, furnishes us with an example.

The roots of some plants have a two-fold direction. Thus in the Primula, or Primrose the main root runs level, whilst the radicles strike perpendicularly downwards into the earth.

Roots are said to be entire when they are not branched. A root of this kind is denominated *Radix simplex*, or simple root. Other roots are subdivided or branched. These are the *Radix ramosa*, or branched root. The *Radix ramossissima* is a root which is greatly subdivided, or branches to a considerable degree. The Podophyllum dyphillum, which I have called Jeffersonia binata, furnishes a good example.

The period of the duration or existence of roots is very different. Some subsist for only one, some for two, and some for many years. The first are denominated annuals: the second biennials: the third perennials. It is also among the herbaceous vegetables, those which have succulent stalks, or stems, that perish down to the root every year, that we have examples of annual and biennial roots. The roots of both herbs and trees are perennials.

The root and the stem of annual plants perish at the end of one year, and the individual dies to rise no more from a root. It is perpetuated, however, by its seed. Gleditsch has compared the annual plants with insects. Like the insects they undergo various metamorphoses, arrive at maturity, perform the office of generation; after which the male quickly perishes, the female surviving some time longer, to nourish and deposit the seed.

Biennials renew their stems only twice, after which the root perishes, the plant being perpetuated by its seed. They are much less numerous than annual or perennial vegetables.

Perennials exist for more than two years. Some of this class preserve both their roots and stems for many years; such are trees, the roots of which have been denominated *Radices fruticosæ*, or shrubby roots, from *Frutex*, a shrub. The stems of other perennials perish to the ground, being annually repaired out of the root.

Climate and cultivation exert a manifest effect upon the duration of roots. When transplanted into cold climates, many of the perennial become annuals, and the species is perpetuated by seed. Thus, in its native warm climate, the Racinus communis, or Castor-oil plant, has a shrubby stem, and is a perennial; but in cold climates, both the root and the stem perish, and the plant is continued by its seed.

The effects of culture, in influencing the term of existence of roots, are much less understood, than the effects of climate. It is certain, however, that, in many instances, it prolongs the life of annual plants.

The greater number of roots are hid below the surface of the earth, and from its bosom they derive a large part of their nourishment and growth. But there are many which are not thus necessarily attached

to the earth. The Misletoe, the Vanilla, the Dodder, the Hypocistis, for example, do not emit their radicles into the soil, but migrate, if I may use the phrase in search of nourishment elsewhere. They attach themselves to other plants, and from which, it is highly probable, they derive *some* of their nourishment. Such plants are denominated by Malpighi, *Plantæ Parisiticæ*, or *Parasitic Plants.*

The Misletoe, the Vanilla, the Tillandsia, and many others, attach themselves to the branches of trees. The Asarum Hypocistis shows a preference to the roots of plants, particularly the Cistus, or Rock-rose; whilst different species of Cuscuta, or Dodder, cling to the stems of a great variety of plants.

Parasitic plants attach themselves to other plants in various ways. The seed of the Dodder having been deposited in the ground, there makes its first effort towards vegetation. It protrudes a stem, which seizes upon the first plant in its vicinity, to which it closely adheres. It is imagined that it derives its nourishment, by means of certain glandular organs, from the supporting plant. The lower part of the stem of the parasitic plant soon dries up, the root perishes, and the parasite lives upon its fulcre or support. It is not certain that it derives any essential part of its nourishment from the juices of the plant to which it attaches itself; but it is highly probable, that, in many instances, parasitic plants injure their supporters, more by emitting from their bodies some noxious fluid, than by absorbing wholesome fluids from the supports.

The Misletoe, the Vanilla, the Tillandsia, and the Hypocistis are never found upon the earth: they appear to have been originally produced upon the vegetables by which they are supported. The two first extend their roots under the bark, and even pierce the body of the wood. The Tillandsia usneoides, which is well known in North America by the names of Long-Moss, and Spanish-Beard, is much more loosely attached to the trees of the forest. This parasite is so abundant in the southern parts of the United States, and in New Spain, that it even communicates a melancholy darkness to extensive woods.

"It is highly probable, that, in many instances, parasitic plants injure their supporters, more by emitting from their bodies some noxious fluid, than by absorbing wholesome fluids from the supports." Actual experiments, however, made with some of the parasitic plants, have very satisfactorily proved, that these plants derive a considerable portion of their nourishment from the vegetables which support them. The stem, the leaves, &c., of the Misletoe may be beautifully colored by diluted Poke juice, and other colouring matters, through the medium of the branches of the Apple, the Gum (Nyssa,) or other tree, from which the parasite proceeds. In this experiment, the Misletoe is not brought into *immediate* contact with the colouring juice: it becomes painted, if I may use the expression, by the juice which, having been previously absorbed by the stock, is from this taken up by the radicles

of the parasite, which are intimately intermixed with the woody part of the supporting vegetable.

The Tillandsia usneoides, or Long-Moss, is only found, in a vigorous state, upon living vegetables; and it is never seen alive on trees that have been dead more than one season. This fact plainly shows, that the Tillandsia derives a large share of its nutriment from the vegetables upon which it grows.

There can be very little doubt, however, that some parasitic plants derive a large, if not the principal, part of their nourishment from the atmosphere. This is, probably, the case with the wonderful Aerides odorata, of which Father Loureiro has given an account. This vegetable, which Willdenow calls Epidendrum flos aeris, is a native of the woods of Cochinchina and of China. It adheres to the trees, by means of a great number of long, linear, radical bulbs, from which it might be conceived to derive its nourishment, if Loureiro did not inform us, that when brought out of the woods, and hung up in the house, without having any connection with the earth or water, it continues, in this situation, during many years, to grow, to flower, and to germinate, exhaling a delightful odour. I shall quote the author's own words, as the book in which the fact is related, is probably in the hands of but few of my countrymen. "Mirabilis hujus plantæ proprietas est, quod ex sylvis domum delata, et in aere libero suspensa, absque ullo pabulo vegetabili terreo, vel aqueo in multos annos duret, crescat, floreat, et germinet. Vix crederem, nisi diuturna experimentia comprobassem."

The roots of many mosses attach themselves to the firm barks of trees, whilst the lichens cling to the hardest stones. Some species seem especially attached to stones of a calcareous nature; whilst others form a beautiful plating upon the surface of whins, sandstones, and granites. It has not yet been determined, with absolute certainty, whence these latter derive their nutriment. It cannot be from the stony substances to which they are attached. It is probable, that they are nourished entirely by the atmosphere, and by water and other extraneous bodies which the atmosphere contains.

Some plants swim upon the water, and even perform pretty extensive migrations. Different species of Lemna, or Duck-meat, swim upon the surface of the standing waters of Europe and North America, and when not disturbed will cover the whole surface. Such plants cannot be said to be fixed to a certain spot. They are furnished with radicles, or roots, but these hang loose in the water, from which, it is probable, they derive their principal nourishment. But the Fuci, or Sea-wreck, an extensive tribe of plants, perform migrations of hundreds of miles upon the ocean, where the eye of the navigator is often enlivened with extensive fields, which are principally composed of these vegetables.

Of the many thousand species of plants that are known, by far the greater number are, unquestionably, furnished with roots. Some, however, are said to be wholly destitute of them. Such are the different

species of the genus Tremella, which have so many of the habitudes of animals, that, by certain writers, they have been considered as belonging more properly to the animal than to the vegetable kingdom.

The root is made up of *Medulla*, or Pith; *Lignum*, or Wood; *Liber*, or Inner Bark; and *Cortex*, or Outer Bark.

L. compares the roots of plants to the absorbing lacteal vessels in animals. The earth he calls the stomach of plants.

SECTION II.—OF THE HERB.

The Herba, or Herb, is that part of the vegetable, which arises from the root, is terminated by the Fructification, and comprehends the Trunk, the Leaves, the Fulcres, and the Hybernacle.

The *Truncus*, or Trunk, is the body or main stem of the vegetable, whether it be a tree, a shrub, or an herbaceous plant. It supports the leaves and the fructification. There are seven species of trunk; 1. the *Caulis*. 2. the *Culmus*. 3. the *Scapus*. 4. the *Pedunculus*. 5. the *Petiolus*. and 6. the *Frons*.

The Caulis, from the Greek, καυλος, stem or stalk, is the body of an herb or tree, supporting branches, leaves and fructification. "To this description," says Dr. Milne, "may be added another circumstance, that caulis is an universal trunk; that is, proceeds immediately from the root, whilst the foot-stalks, of the flower and leaf, which L. likewise denominates trunks, are partial; that is, proceed from an universal trunk, or its branches." The caulis is the most common species of trunk, strictly so called.

The stems or trunks of the grasses, the palms, the ferns, and the fungous plants, are distinguished by particular appellations, which will be noticed in their proper places.

I have said, that the caulis is the stem or trunk whether of herb or tree, formerly the term caulis was applied to herbs only. The term truncus, which was employed to denote the stem, or trunk, or bole of a tree, is now employed as a generic name, of which the terms caulis, culmus, &c. are species.

The caulis, or stem, is either simple or compound.

"Simple stems are such as do not divide, but proceed in a continued series towards their summits. Compound stems are subdivided into *ramuli*, or small branches, and diminished as they ascend, so as frequently to lose the appearance of a stem altogether."

The following are varieties of the *caulis simplex*, or simple stem; viz. 1. *caulis nudus*, a naked stem, or a stem devoid of leaves and hair. 2. *caulis foliatus*, a leafy stem, or stem covered with leaves. 3. *caulis flexuosus*, a fluxuose stem, or stem which takes a different direction at every joint. 4. *caulis volubilis*, a twining stem, or stem which ascends in a spiral direction, round the branch or stem of some other plant, or round some prop. 5. *caulis reclinatus*, a reclining stem,

bending in an arch towards the earth. 6. *caulis procumbens,* a procumbent stem, lying along the ground, but not putting forth roots. 7. *caulis repens,* a creeping stem, or stem running along the ground, and striking root at certain distances. 8. *caulis sarmentosus,* or sarmentose stem; a slender stem almost naked, or having only leaves in bunches, at the joints or knots, where it strikes root. 9. *caulis parasiticus,* or parasitical stem; a stem which does not grow immediately from the ground, but depends for its support upon some other vegetable. 10. *caulis teres,* a columnar stem, or stem without angles. 11. *caulis anceps,* or ancipital stem; a two-edged stem, compressed and forming two opposite angles. 12. *caulis triqueter,* or three-sided stem, having three plane or flat sides. 13. *caulis triangularis,* or triangular stem, with three angles. 14. *caulis trigonus,* or three cornered stem, having also three angles, with the sides concave or convex. 15. *caulis sulcatus,* or furrowed, grooved or fluted stem; a stem marked, its whole length, with grooves, or channels. 16. *caulis striatus,* a striated or streaked stem; a stem marked, its whole length, with superficial or slight grooves or channels. 17. *caulis glaber,* a smooth stem. 18. *caulis scaber,* a scabrous or rugged stem, something like shagreen. 19. *caulis vilusus,* a vilose stem; a stem covered with down or soft hairs: and 20. *caulis hispidus,* a hispid stem, covered with bristly-like arms, or minute prickles.

The following are varieties of simple branching stems. 1. *caulis adscendens,* or ascending stem; a stem whose branches grow, at first, in a horizontal direction, and then gradually curve upwards. 2. *caulis diffusus,* or diffused stem; a stem furnished with spreading branches. 3. *caulis distichus,* from δις, twice, and τιχος, a rank, or row, a distich, or two-ranked stem; a stem with the branches horizontal, and produced in two rows: or, in other words, it is a stem whose branches proceed from only two sides of the stem. 4. *caulis brachiatus,** from *brachium,* the arm, or bracheate stem; a stem having branches, stretched out like arms in pairs, and all nearly horizontal, each pair being at right angles with the next. 5 *caulis ramosissimus,* a stem very much branched; the branches disposed without any regular order. 6. *caulis fulcratus,*† or fulcrated stem. This species of stem is supported by the branches, which descend to the root; as in the Fig-tree, and the Rhizophora, or Sea-Mangrove. 7. *caulis prolifer,* a proliferous stem that puts forth branches only from the centre of the summit: as in the Pine, Fir, Cedar, &c. 8. *caulis simplicissimus,* the most simple stem, having very few branches, and proceeding in a straight line to the top, as in the Lathræa Squamaria. 3. Of the *caulis compositus,* or compound stem, the following species are mentioned by L. viz. 1. *caulis dichotomus,*‡ a dichotomus stem, or stem which continually and regularly

* Brachiatus, from *Brachium,* the arm.

† *Fulcratus,* from *Fulcrum,* a prop.

‡ *Dichotomus* from δις, twice, and τέμνω, to cut: or from δικα and τεμνω, to divide by pairs.

divides by pairs, from the top to the bottom. This is instanced in the Viscum, or Misletoe, the Valeriana Locusta, called Corn-sallad, the Chironia angularis, or American Centaury, and others. 2. *caulis subdivisus*, a stem divided into branches irregularly, or without order. 3. *caulis articulatus*, a jointed stem, having knots or joints situated at certain distances. To the terminology of caulis, I add *caulis floriferus*, a flower-bearing stem. We have a fine example of this in the beautiful Cercis canadensis, or Canadian Salad-tree; called also Shad-blossom. The trunk, as well as branches, is covered with tufts of the rose-coloured blossoms: a circumstance which adds much to the beauty of the tree, especially as its leaves do not make their appearance until the flowers have begun to fade or disappear.

II. The Culmus, which may very properly be translated, Culm, but which is also called the Straw or Haulm,* is defined, by L. to be the proper trunk of the gramina, or grasses, elevating the leaves, the flower, and the fruit. "The word Straw being commonly appropriated to the dry stalk of corn, I prefer using the Latin culm."† This species of stem is generally tubular, or hollow, and has very frequently knots or joints distributed, at certain intervals through its whole length. Most of the grasses have a round and cylindrical stem, as in the Wheat, the Rye, the Oat, and many others. Some species of grasses, however, have a triangular culm. We have instances of this in several species of Schoenus, Scirpus, Cyperus, &c. The culm is very frequently interrupted by knots or joints; as in the Wheat, Indian-corn, or Maize, &c. This is the *culmus articulatus*, or jointed culm. But the culms of some species of grasses are entirely destitute of such knots. These are the *culmus enodis*, or knotless culm. The interval, or space, contained between every two joints of a jointed culm is called *Internodium*, and *Articulus culmi*. To avoid all ambiguity, it may not be improper to anglicize the Latin word internodium, by using the word Internode, as a learned veteran‡ in the science of Botany has done.

In the greater number of grasses, the culm is garnished with leaves, as in the Wheat, Rye, Indian-corn, &c. In some species, the culm is entirely naked, that is destitute of leaves. This is the case in certain species of Cyperus, or Cypress-grass. The culms of the greater number of the grasses of the temperate countries are entire, that is not branched. In the Indies, however, many of the grasses have branched culms. The culm sometimes consists of a number of scales, which lie over each other, in the manner of tiles upon a house. The culm of an Asiatic species of grass§ is said to attain to the height of sixty or an hundred feet. Even within the limits of the United States, one species‖ of Arundo, or Reed, whose stem is a culm, grows to the height of thirty feet. "The culm sometimes consists of a number of scales, which lie over each other, in the manner of tiles upon a house."—I

* Haum, or Haume, is the older English spelling adopted from the Saxon.
† Professor Martyn. ‡ Professor Martyn.
§ Panicum arborescens, a native of Ceylon. ‖ Arundo gigantea of Walter.

think it has not yet been ascertained what culm, if any such exist, L. here alludes to. A *culmus imbricatus* is unknown to the botanists. It is possible that L. had his eye upon some figure of the stem of a Palm. Plants that are furnished with the particular species of stem which I have been speaking of, are known among botanists by the name of *Plantæ Culmiferæ*, or Culmiferous plants. By L. they are denominated *Gramina*, or Grasses. Mr. Jussieu calls them *Gramineæ*. 3. The Scapus* or Scape, as Dr. Martyn translates the word, is a species of stem, or trunk, which supports the fructification, but not the leaves. The scape, like the caulis, is an universal stem, in which respect it differs from the pedunculus, or peduncle. The scape proceeds immediately from the root, whereas the peduncle proceeds always from the stem, or branches of the stem. The scape also differs from the *caulis aphyllus*, or leafless stem, because although the scape is naked, that is without leaves, it has, nevertheless, always radical or bottom leaves: but the naked stem is entirely destitute of leaves.—Dr. Milne observes, that in the *Species Plantarum* of L. "the term *Scapus* is generally "preceded by the superfluous word *naked;* an addition which is apt to mislead the unexperienced botanist, as seeming to imply, that nakedness is not an essential part in the description of this species of stalk." L. has observed, that the "scapus is only a species of pedunculus." "The term, says Dr. Smith, might therefore be spared, were it not found very commodious in constructing neat specific definitions of plants. If abolished, *Pedunculus radicalis*, or radical flower-stalk, should be substitued." I cannot agree with L. and Dr. Smith. The term *scapus* cannot well be spared: its *origin* emphatically distinguishes it from the *pedunculus*, with which, in describing plants, it ought never to be confounded. A physiological circumstance concerning the scape deserves to be mentioned here. L. thought, "that a plant could not be increased by its scapus." But Dr. Smith "has had scaly buds from even on the flower-stalk (scapus) of Lachenalia tricolor, *Curt. Mag. t.* 82., whilst lying for many weeks between papers to dry, which, on being put into the ground, have become perfect plants, though of slow growth." *Introduction*, &c. page 112. Is the *true* pedunculus capable of continuing a plant? I have not determined the point by actual experiment: but I have little doubt, that the peduncles of *many* plants, as well as the scape of Lachenalia, is capable of forming buds, or bulbs *(propagines,)* from which a plant similar to the parent, may be evolved. It must, however, be observed, that in some plants,† what is called the scape is not wholly leafless.

The following, among many other plants, furnish us with examples of the scape: viz. the Narcissus, the Pyrola, or Winter-green, the Con-

* Scapus, originally from σκηπτω, to lean upon; but more immediately from the classical Latin word, *scapus*, the upright stem of an herb, the shaft of a column, &c.

† Tussilago alpina &c.

vallaria majalis, or Lily of the valley, the Hyacinthus, or Hyacinth, the Dionæa Muscipula, the Sarracenia purpurea, the Hypoxis erecta, and the Sagittaria sagittifolia.*

4. The Frons, or Frond, is the sixth species of trunk enumerated by L. He defines it to be a kind of trunk or stem, which has the branch united with the leaf, and frequently with the fructification. In other words, it is a stem, "in which the leaves are confounded with the stem and branches, and frequently with the flower and fruit." L. restricts this species of stem to the Ferns and Palms. Some respectable writers do not agree with L. in considering the frond, as a species of trunk. It does not, indeed, appear in what very essential circumstance the frond does differ from a true compound leaf. Its two sides are very distinct from each other, in which respect, it agrees with almost all known leaves: but differs from the other species of *real* stems, the two sides of which are no way different from each other. It must be observed, however, that the upper and under surfaces of the petiolus, and pedunculus; which the Swedish naturalist considers as species of trunk, are often, like the upper and under surfaces of the leaves, and frons, distinct, in their appearance, from one another. I think, upon the whole, that we should do no injury to the science of plants, were we to exclude, entirely, the frond from the list of stems. Willdenow has totally omitted *frons* in his list of stems, or trunks. I think this is right. He retains stipes: and he thinks proper to consider the *pedunculus* and the *petiolus* as species of stems. So does Smith.—The first of these writers restricts the term *caulis* to the herbaceous vegetable: and he employs *truncus* to designate the stem of the trees and shrubs. His truncus is two-fold: viz. 1. *truncus arboreus*, that has a crown of branches at top: and 2. *t. fruticosus*, that has branches also below. I am not confident that this distinction is of much consequence. Mr. Willdenow adds two species of stem to the list: viz. *Surculus*, and *Seta*.

1. The Surculus, or Shoot, is the stem which bears the leaves of the mosses. This is either, 1. *simplex*, simple; having no branches, as in Polytrichum: see our Plate xxxi. 2. *ramosus*, branched; dividing into branches, as in Mnium androgynum. 3. *ramis deflexis*, with hanging branches; when the stem is branched, but all the branches hang down, as in Sphagnum palustre. 4. *decumbens*, decumbent; that lies on the ground. 5. *repens*, creeping: and 6. *erectus*, upright.

2. The Seta, or Bristle, is that species of stem, which in the mosses supports only the fructification, without leaves.† It is always simple, and never branched, as in the preceding species. The seta is sometimes, 1. *solitaria*, solitary. 2. *aggregata*, aggregate; or crowded. 3. *terminalis*, terminal; on the point: or, 4. *axillaris, vel lateralis*, on the side.

* See, in this work, the figures of the four last mentioned plants.

† It may be said to be the scapus of the mosses. See Plates xxx. and xxxi.

5. The Stipes,* or Stipe, is the seventh and last species of trunk enumerated by L. He defines it to be the base of the frond, last mentioned, and he restricts it to the ferns, palms, and fungous plants. The stem of the last-mentioned family of plants (comprehending the numerous species of mushrooms, &c.) is called by Dr. Withering, the Pillar. The term stipes, or stipe, is also put by L. for the thread, or slender stem, or foot-stalk, which, in many of the compound flowers, belonging to the class of Syngenesia, elevates the feather-like or hairy crown (called *Pappus*,) with which the seeds are furnished, and connects it with the seed. This appearance is sufficiently conspicuous in the common Lettuce, the Dandelion (Leontodon Taraxacum,) the Colts-foot (Tussilago,) and many other plants. Of the Pedunculus and Petiolus (known among English botanists by the names of Peduncle and Petiole,) I shall treat particularly under the head of *Fulcra*, of Fulcres.

The *Folium*, or Leaf, is the next part of the herba, that demands our attention.

L. defines the leaf to be "the organ of motion in a vegetable:" "Organum motus plantæ." But these words convey no manner of idea of the form or structure of the leaf. They only tell us, what the Swedish naturalist deemed to be the true use of leaves in the vegetable economy. Professor Ludwig defines leaves to be fibrous and cellular processes of the plant, which are of various figures, but generally extended into a plain membranaceous, or skinny substance.† Miller's definition of the leaf, might serve as a definition of almost every other part of the plant. I shall treat of leaves, under the following heads: viz. I. of leaves in regard to their *nomenclature:* II. of the *anatomical structure* of leaves: III. of the *uses* of leaves in the vegetable economy; and, IV. and lastly of certain *miscellaneous circumstances*, in the natural history of leaves.

A. I. Of the Nomenclature of Leaves.

Leaves, considered in respect to their nomenclatural history, may be treated of under the three following heads, viz. 1. of *Simple Leaves*: 2. of *Compound Leaves:* and, 3. of *Leaves according to their Determination*. 1. The *Folium Simplex*, or Simple Leaf, is that species of leaf, which consists of only one, undivided portion, situated upon a petiole, or foot-stalk. In other words, the simple leaf is a leaf whose petiole is terminated by a single expansion, the divisions of which, however deep they may be, do not reach to the middle rib. "To understand this, let it be observed, that the middle rib of every leaf is the principal prolongation of the foot-stalk, which, to form the membranaceous expansion, called the leaf, runs out—into a number of ramifications, that inosculating and crossing each other mutually, form the cortical net" of the leaf. "When these ramifications of the footstalk are so connected, as to form one entire expansion, the leaf is said

* Stipes, originally from σἶοτος, a stake.
† Ludwig, as quoted by Milne.

to be simple; but when the middle rib becomes, in fact, a foot-stalk, and many different expansions, instead of one, proceed from the common foot-stalk, the leaf, is said to be compound." The middle rib of a leaf, whether it be simple, or compound, is denominated by L. costa. Of this more particular mention will be made, hereafter. The forms of the simple leaf are almost innumerable. I shall here mention the greater number of those which are noticed by L. in his *Philosophia Botanica.* They are the following. viz. 1. *folium orbiculatum*, an orbicular, or circular leaf. 2. *folium subrotundum*, a leaf nearly round. 3. *folium ovatum*, an ovate, or egg-shaped leaf. 4. *folium ovale*, an oval leaf. 5. *folium parabolicum*, a parabolic leaf. 6. *folium spatulatum*, a spatulate, or spatula-shaped leaf. 7. *folium cuneiforme*, a cuneiform, or wedge-shaped leaf. 8. *folium oblongum*, an oblong leaf. 9. *folium lanceolatum*, a lanceolate leaf. 10. *folium lineare*, a linear leaf, as the leaves of the grasses. 11. *folium acerosum*, or acerose leaf; a leaf which is linear and permanent, as in the Pine, Yew, and many other evergreen trees. 12. *folium subulatum*, a subulate leaf; linear at the bottom, but gradually tapering towards the end. 13. *folium triangulare*, a triangular leaf. 14. *folium quadrangulare*, a quadrangular leaf. 15. *folium quinquangulare*, a five-cornered leaf. 16. *folium deltoides*, a deltoid leaf. 17. *folium rotundum*, a round leaf. 18. *folium reniforme*, a reniform or kidney-shaped leaf. 19. *folium cordatum*, a cordate or heart-shaped leaf. 20. *folium lunulatum;* shaped like a crescent. 21. *folium sagittatum*, a sagittate leaf; a leaf shaped like the head of an arrow.* 22. *folium hastatum*, a hastate leaf; a leaf resembling the head of a halbert. 23. *folium panduræforme*, a guitar-shaped leaf; as in Convolvulus panduratus, called Wild-Potatoe, &c. 24. *folium fissum*, a cleft-leaf; a leaf divided by linear sinuses, with straight margins. (According to the number of these divisions, the leaf is called, bifid, trifid, quadrifid, quinquefid, multifid, *bifidum, trifidum, quadrifidum, quinquefidum, multifidum, &c.)* 25. *folium lobatum, a lobate or lobed leaf.* 26. *folium palmatum*, a palmate or hand-shaped leaf. 27. *folium pinnatifidum*, a pinnatifid leaf. 28. *folium lyratrum*, a lyrate, or lyre-shaped leaf. 29. *folium laciniatum*, a laciniate, or jagged leaf. 30. *folium sinuatum*, a sinuate leaf. 31. *folium partitum*, or parted leaf; a leaf divided almost down to the base. (According to the number of the divisions, the parted leaf is called bipartite, or two-parted; tripartite, or three-parted, &c. &c. *bipartitum, tripartitum, quadripartitum, quinquepartitum, multipartitum.)* 32. *folium integrum*, an entire leaf. 33. *folium truncatum*, a truncate leaf; ending in a transverse line, so that it seems as if the tip of the leaf had been cut off: beautifully illustrated in the Liriodendron Tulipifera, or Tulip-tree, of North-America. 34. *folium præmorsum*, a leaf ending very obtusely, with unequal notch-

* As in Sagittaria sagittifolia, of which see the figure in this work.

es.* 35. *folium retusum*, a retuse leaf; ending in a blunt sinus. 36. *folium emarginatum*, a leaf notched at the end. 37. *folium obtusum*, an obtuse or blunt leaf. 38. *folium acutum*, an acute leaf, ending in an acute angle. 39. *folium acuminatum*, an acuminate or sharp-pointed leaf; ending in a subulate or awl-shaped point. 40. *folium cirrhosum*, a cirrose leaf; terminating in a tendril. 41. *folium spinosum*, a spiny or thorny leaf. 42. *folium dentatum*, a toothed leaf. 43. *folium serratum*, a serrate leaf, toothed like a saw. 44. *folium crenatum*, a crenate leaf; having the edge cut with angular or circular incisures, not inclining towards either extremity. 45. *folium repandum*, a repand leaf; having its rim terminated by angles, with sinuses between them. 46. *folium cartilagineum*, a cartilaginous leaf. 47. *folium ciliatum*,† a ciliate leaf; having the edge guarded by parallel bristles, longitudinally. 48. *folium lacerum*, a lacerated leaf; with the edge variously cut, as if it were torn. 49. *folium erosum*, an erose or gnawed leaf; as if gnawed by insects. 50. *folium integerrimum*, absolutely entire; the margin or edge not in the least cut or notched. 51. *folium viscidum*, a viscid leaf; covered with a tenacious juice. 52. *folium tomentosum*, a tomentose, downy or cottony leaf. 53. *folium lanatum*, a woolly leaf; covered with a substance resembling a spider's web. 54. *folium pilosum*, a hairy leaf; having the surface covered with long, and distinct hairs. 55. *folium hispidum*, a hispid leaf (see *caulis hispidus*.) 56. *folium scabrum*, a scabrous or rugged leaf (see *caulis scaber*.) 57. *folium aculeatum*, a prickly leaf; armed with prickles. 58. *folium striatum*, a striated or streaked leaf. 59. *folium papillosum*, a papillose leaf; having the surface covered with fleshy dots. 60. *folium punctatum*, a dotted leaf. 61. *folium nitidum*, a glittering or glossy leaf. 62. *folium plicatum*, a plaited leaf; folded like a fan. 63. *folium undulatum*, a waved leaf; with the surface rising and falling in waves, or obtusely. 64. *folium crispum*, a curled leaf. 65. *folium rugosum*, a wrinkled leaf. 66. *folium concavum*, a concave leaf; or leaf with the edge standing above the disk. 67. *folium venosum*, a veined leaf; a leaf whose vessels branch, or variously divide over the surface. (When a leaf has no perceptible vessels, it is called *folium avenium*, a veinless leaf.) 68. *folium nervosum*, a nerved leaf; having vessels quite simple and unbranched, extending from the base towards the apex, or tip. 69. *folium coloratum*, a coloured leaf; of any other colour than green. 70. *folium glabrum*, a smooth leaf. 71. *folium teres*, a columnar leaf; a leaf without angles. 72. *folium tubulosum*, a tubulous or hollow leaf, as in the Onion; and most singularly in the Sarracenia purpurea.‡ 73. *folium carnosum*, a fleshy leaf: full of pulp within, as in Sedum, and many other succulent leaves. 74. *folium compressum*, a compressed or flatted leaf. 75. *folium planum*, a plane or flat leaf; having the two surfaces parallel.

* See radix præmorsa.

† From *Ciliæ*, the eye-lashes.

‡ See Plate 1.

76. *folium gibbum*, a gibbous leaf; having both surfaces convex, owing to the abundance of pulp. 77. *folium convexum*, a convex leaf; with the edge more contracted than the disk. 78. *folium depressum*, a depressed leaf; hollow in the middle, having the disk more depressed than the sides. 79. *folium canaliculatum*, a channelled leaf; hollowed above with a deep longitudinal groove, convex underneath. 80. *folium ensiforme*, a sword-shaped leaf; tapering from the base towards the point. 81. *folium acinaciforme*, an acinaciform leaf; fleshy and compressed, resembling a sabre, faulchion or scymitar. 82. *folium dolabriforme*, a dolabriforme, axe, or hatchet shaped leaf. 83. *folium linguiforme*, a tongue-shaped leaf; "linear and fleshy, blunt at the end, convex, underneath, and having usually a cartilaginous border." 84. *folium anceps*, an ancipital leaf; having two prominent longitudinal angles, with a convex disk. 85. *folium triquetrum*, a three-sided leaf (see *caulis triqueter.)* 86. *folium sulcatum* a furrowed, grooved or fluted leaf (see *caulis sulcatus.*) 87. *folium carinatum*, a carinated leaf; having upon the back a longitudinal prominency, like the keel of a vessel. 88. *folium membranaceum*, a membranaceous leaf; having no perceptible pulpy matter between the two surfaces.

II. "Compound leaves are such whose footstalk is terminated by several expansions; in other words, whose divisions extend to the common footstalk, which not running into the membranaceous part of the leaf, supports the several lobes, or lesser leaves, called *foliola*, of which the compound leaf consists." The foliola, or leaflets, as Dr. Martyn translates the word, are true simple leaves, the forms of which are, like those of the simple leaves already treated of, very numerous. These leaflets are sometimes furnished with particular footstalks; sometimes they are destitute of such footstalks, but are seated upon the middle rib of the compound leaf. The former leaflet is denominated *foliolum petiolatum*, a petioled leaflet; the latter *foliolum sessile*, a sessile leaflet. In the compound leaves, of which I am speaking, the central longitudinal fibre, or part to which the leaflets are attached, is denominated the costa, or rib. I have already observed, that the central fibre of the leaves, whether simple or compound, is known by the same name. This part of the leaf is by some writers denominated a nerve. This term ought not to be admitted in an accurate botanical language, since there is no reason to believe that any peculiar sensibility, the attribute of nervous matter, resides in the central fibre. It has also been called a vein. To this term there is less objection than to the former, since it is demonstrated, as I shall afterwards show, that a fluid circulates or moves through every part of the leaf, along the course of the middle rib, and of the branches, which it sends out. Professor Ludwig has proposed to call by the name of nerve, the prominent division of the rib of the leaf, and by the name of vein, the pellucid part of the rib.* I think, however, that no manner of ad-

* Institutiones, &c. p. 26.

vantage is gained by this nice distinction. Compound leaves are distinguished by L. into, 1. compound leaves, properly so called. 2. leaves twice compounded; and, 3. leaves that are more than twice compounded.

A. The *folium compositum*, or compound leaf properly so called, is a leaf only once compounded, and admits of the following species or varieties, which I shall mention in the order in which they occur in the *Philosophia Botanica*. 1. *folium articulatum*, a jointed leaf; when one leaflet grows from the top of another. 2. *folium digitatum*, a digitate leaf; when a simple or undivided footstalk connects several distinct leaflets at the end of it; as in different species of Æsculus, or Horsechesnut.* 3. *folium binatum*, a binate leaf; having a simple petiole connecting two leaflets at the top of it; as in Jeffersonia binata, &c. 4. *folium ternatum*, a ternate leaf; having three leaflets on one petiole; as in Trefoil, Strawberry, &c. 5. *folium quinatum*, a quinate leaf; having five leaflets on one petiole. (L. considers the binate, the ternate and the quinate leaves as species of the digitate leaf.) 6. *folium pinnatum*, a pinnate leaf; composed of a number of leaflets, arranged, like wings, along both sides of the middle rib. Of this beautiful kind of leaf, we have many examples, but the finest occur in the leguminous plants, as they are called; as in different species of Robinia, Cassia, &c. &c. &c†. To this general head of the pinnate leaf, L. refers various species or varieties, such as 1. *folium pinnatum cum impari*; unequally pinnate, when the wings composed of leaflets are terminated by a single leaflet; as in Robinia viscosa. 2. *folium pinnatum cirrhosum;* cirrhosely pinnate; terminated by a tendril. 3. *folium pinnatum abruptum*; abruptly pinnate; neither terminated by a leaflet nor by a tendril. 4. *folium pinnatum opposite*; oppositely pinnate; having the leaflets placed opposite to each other, in pairs, as in Cassia marilandica. 5. *folium pinnatum alternatim*; alternately pinnate; the leaflets ranged alternately along the common petiole. 6. *folium pinnatum interrupte;* interruptedly pinnate; having smaller leaflets interposed between the principal ones. 7. *folium pinnatum articulate;* jointedly pinnate; when the common footstalk is articulated, or jointed. 8. *folium pinnatum decursive;* decursively pinnate; when the leaflets run into one another along the common petiole. 9. *folium conjugatum*, a conjugate leaf; having only one pair of leaflets.

B. The *folium compositum decompositum*, or decompound leaf, is so called, when the primary petiole is so divided that each part forms a compound leaf: in other words, the footstalk, instead of supporting small lobes, or leaflets, on the top, or on each side, bears partial footstalks, from which proceed the leaflets on both sides. To this head, L. refers the following species of leaves, viz. 1. *folium bigeminatum*, or bigeminate leaf; having a dichotomous or forked petiole,

* See the plate of Æsculus spicata, in this work.

† See the plates of Robinia viscosa and Cassia marilandica.

with several leaflets at the extremity of each division. 2. *folium biternatum*, a biternate or doubly-ternate leaf; when the petiole has three ternate leaflets; as in Epimedium. 3. *folium bipinnatum*, a doubly-winged leaf, or frond; when the common petiole has on each side of it pinnate leaves.* 4. *folium pedatum*; a pedate leaf; when a bifid or forked petiole connects several leaflets on the inside only: as in Passiflora, Arum, Helleborus fœtidus, &c.

C. The *folium compositum supradecompositum*, or supradecompound leaf, is a species of compound leaf, in which the petiole, being several times divided, connects many leaflets, each part forming a decompound leaf: as in Pimpinella glauca, Ranunculus rutæfolius, &c. To this head L. refers the following species, viz. 1. *folium triternatum*, a triternate or triply-threefold leaf; when the petiole has three biternate leaves. 2. *folium tripinnatum*, a tripinnate, or three times pinnate-leaf; when the petiole has bipinnate leaves ranged on each side of it; as in in the Pteris aquilina, and other ferns. 3. *folium tergeminum*, a tergeminate or thrice-double leaf; "when a forked petiole is subdivided, having two leaflets at the extremity of each subdivision; and also two other leaflets at the division of the common petiole."†

III. The Determination or Disposition of leaves, whether they be simple or compound, comprehends the following particulars, viz *a*, the *locus*, or place of the leaf. *b*, its *situs*, or situation, *c*, its *insertio*, or insertion, and *d*, its *directio*, or direction. *a*. By the place of a leaf, botanists mean the particular part where it is attached to the plant. Under this head, L. enumerates the following species of leaves, viz. 1. *folium seminale*, the seed-leaf; the primary leaves of the plant; being the cotyledons or lobes of a seed expanded, and in a vegetating state.‡ 2. *folium radicale*, a root-leaf; proceeding immediately from the root, and not adhering to the stem.§ 3. *folium caulinum*, a cauline leaf; growing immediately on the stem, without the intervention of branches. 4. *folium rameum*, a branch-leaf, growing on, or proceeding from, a branch. 5. *folium axillare*, an axillary leaf; growing at the angle which is formed by the branch with the stem. 6. *folium florale*, a floral leaf; immediately attending the flower, and never appearing but with it. This last must not be confounded with the *bractea*, or bracte. *b*. The situation of leaves respects their position in regard to themselves. Under this head, L. enumerates the following species of leaves, viz. 1. *folia stellata*, or stellate leaves; when more leaves than two surround the stem in a whorl, "or radiate from the stem like the spokes of a wheel," exemplified in the Medeola verticillata, and Cucubalus stellatus.|| Such leaves are also called verticillate leaves. 2.

* As in Athamanta Libanotis, many Ferns, &c.

† Professor Martyn.

‡ See Plate V.

§ See the plates of Dionæa Muscipula and Hypoxis erecta.

|| See the figures of these two vegetables.

folia terna, quaterna, quina, sena, &c. three-fold leaves, four-fold leaves, five-fold leaves, six-fold leaves: different species or varieties of stellate leaves, when the leaves grow, in a whorl, three together, four, five, and six together. 3. *folia opposita*, opposite leaves; growing in pairs, each pair decussated, or crossing that above and below it."* 4. *folia alterna*, alternate leaves; coming out one after or above another, in a regular succession, or gradation; as in Ludvigia alternifolia.† The term alternate is opposed to the opposite. 5. *folia sparsa*, scattered leaves; neither opposite nor alternate, nor in any regular order: as in several species of Lily. 6. *folia conferta*, crowded or clustered leaves; leaves so copious as to occupy the whole of the branches, hardly having any naked space between: as in the Antirrhinum Linaria, called in Pennsylvania, Ranstedweed. 7. *folia imbricata*, imbricate leaves; lying over each other in the manner of tiles upon a house. 8. *folia fasciculata*, fascicled leaves; growing in bundles or bunches from the same point; as in the Larch-tree. 9. *folia disticha*, two ranked leaves; leaves respecting only two sides of the branch, though inserted on all parts of it: as in the Fir, and Lonicera Diervilla.

For as in different species of Nymphaea, &c., *ending* or May-apple, *read*, as in the majestic Nelumbo lutea, which adorns some of the wet meadows in the vicinity of Philadelphia; in the Tropaeolum, or Indian-Cress; in the Geranium peltatum; the Podophyllum peltatum, or May-apple; the Hydropeltis purpurea (See Plate xxxii. Fig. 12.) the Diphylleia cymosa, figured by Michaux, *Flor. bor. amer. tom.* i. *tab.* 19, 20., and in many others. 2. A leaf is said to be centro-peltate, *folium centropeltatum*, when the foot-stalk is inserted directly, or nearly, in the centre of the leaf, as in the Nelumbo and Hydropeltis, just mentioned.

c. By the insertion of the leaves, is meant the manner in which they are attached to the plant. To this head, L. refers the following species of leaves, viz. 1. *folium peltatum*, a peltate, or target-shaped leaf; having the footstalk inserted into the disk of the leaf, instead of the edge or base, which is the more common mode of insertion: as in different species of Nymphæa, such as the Nymphæa Nelumbo, Nymphæa odorata, &c. in the Tropæolum, or Indian-cress, which is mentioned in Part Second; in the Geranium peltatum, and the Podophyllum peltatum, or May-apple. 2. *folium petiolatum*, a petiolate or petioled leaf; growing on a petiole or footstalk, which is usually inserted into its base: as in the greater number of leaves. The term is opposed to sessile. 3. *folium sessile*, a sessile leaf; a leaf which is immediately connected with the stem or branch, without the intervention of a footstalk; as in Rhexia virginica.‡ 4. *folium decurrens*, a

* See the figures of Collinsonia canadensis, Veronica, Rhexia mariana, Gerardia flava, and other plants represented in this work.

† See the figure.

‡ See the figure.

decurrent leaf; a sessile leaf, with its base extending downwards along the trunk, or stem: as in Symphytum, or Comfrey, Carduus, or Thistle, &c. 5. *folium amplexicaule*, a stem-clasping-leaf, embracing, clasping, or surrounding the stem by its base (N. B. some leaves go only half round the stem: these are denominated *folia semi-amplexicaulia*, or half-stem-clasping leaves.) 6. *folium perfoliatum*, a perfoliate or perforated leaf; having the base of the leaf entirely surrounding the stem transversely; so that the stem appears to have deen driven through the middle of the leaf: as in Bupleurum rotundifolium, Eupatorium perfoliatum, or Thorough-wort, &c. 7. *folium connatum*, a connate leaf; when two opposite leaves are so united at their bases as to appear as though they were one leaf: exemplified in the Garden Honeysuckle, &c. 8. *folium vaginans*, a sheathing leaf;* when a leaf invests the stem or branch by its base, in form of a tube: as in many Grasses, Polygonum, Rumex, *&c.* *d.* With respect to their direction, leaves are as follows, viz. 1. *folium adversum*, an adverse leaf; when the upper side is turned to the south: as in Amomum. 2. *folium obliquum*, an oblique leaf, having the base directed towards the sky, and the apex, or point, towards the horizon: as in Protea and Fritillaria. 3. *folium inflexum*, an inflex or inflected leaf; bent upwards, at the end, towards the stem. 4. *folium adpressum*, an appressed leaf; when the disk approaches so near to the stem, as to seem as if it was pressed to it by violence. 5. *folium erectum*, an erect or upright leaf; when it makes with the stem an angle so acute as to be close to it. 6. *folium patens*, a spreading leaf; forming an acute angle with the stem or branch upon which it is placed; between the erect and horizontal position. 7. *folium horizontale*, a horizontal leaf; making a right angle with the stem, the upper disk being turned towards the heavens. 8. *folium reclinatum*, a reclined leaf; bent downwards, so that the point of the leaf is lower than the base. 9. *folium revolutum*, a revolute leaf; having the edges rolled back, or towards the lower surface; as in Rosemary, Kalmia glauca, &c. 10. *folium dependens*; a leaf hanging down, or pointing directly to the ground. 11. *folium radicans*, a rooting leaf, a leaf shooting forth radicles, or roots; as in some aquatic plants. (This term is also applied to those leaves which being planted in the ground, there strike root and vegetate: such are the solid and fleshy leaves of several of the Liliaceous plants, the Aloe, Squill, &c. also the leaf of the Orange, and many other vegetables.) 12. *folium natans*, a floating leaf; a leaf which lies or floats upon the surface of the water, as in Nymphæa, Potamogeton, Trapa natans, &c. and 13, and, lastly, the *folium demersum*, or demerse leaf; called also a drowned or sunk leaf, a leaf which grows below the surface of the water: this is exemplified in Vallisneria spiralis and Vallisneria americana, especially the male plants; and in many other aquatic plants.—Some plants are constantly placed below the surface of the water,

* "A glove-like leaf." Milne.

whilst others withdraw themselves to the bottom of the water, in which they grow, in order to avoid the rigour of the winter-season.

The whole surface of a leaf is denominated the *Discus*, or the Disk. The upper surface is called *Discus supinus;* the under *Discus pronus,* the upper and under disk. *Pagina superior*, and *Pagina inferior* are also the names of the two disks, or surfaces. The *apex*, tip or end of the leaf, is the upper extremity, farthest removed from the base or insertion.

Ludwig and some other writers have distinguished leaves into primary and accessary. The primary are those of which I have already treated: the accessary are those which L. denominates *stipulæ* and *bracteæ*.

A knowledge of the leaves of plants is of the utmost importance in the study of Botany. In the investigation of the species of vegetables, there are no parts, which furnish us with such elegant characters or marks as do the leaves. Nature seems to have taken delight in giving to the leaves, forms almost innumerable.* Without being acquainted with the principal and more determinate of these forms, it is impossible to make an extensive progress in the attainment of botanical knowledge. It is from the leaves, that some of the most eminent botanists, particularly Mr. Ray, Adrian Van Royen, and L. have taken the greater number of their specific names or characters of plants. The last-mentioned writer lays it down as an axiom, that the leaves exhibit the most elegant natural differences†. He allows, that good marks of distinction are afforded by the root, and the trunk, and other parts of the plant.

As the leaves of plants are subject to great variation, in respect to their forms and substance, and even in respect to their situation. I cannot but think, that many botanists have laid too implicit a dependence upon their characters drawn from them. It is certain, that soil, climate, elevation above the level of the sea, and other circumstances, considerably vary the aspect of the leaves of vegetables. How different, in many instances, are the leaves of the same species of plant, when growing in a northern and more southern climate. How different the same species when confined to the valley or the plain; or elevated, far above the level of the sea, upon the sides or summits of lofty mountains? How different the same species when growing in a dry and in a wet situation?

L. observes, that opposite and alternate leaves generally indicate very different plants, with the exception of such genera as contain

* "Natura in nulla parte magis fuit polymorpha, quam in folus, quorum itaque species numerosissimæ, studiose a Tyronibus addiscendæ." Philosophia Botanica, &c. p. 218.

† "Folia elegantissimas naturalissimas differentias exhibent." Philosophia Botanica, &c. p. 218.

some species that have opposite, and others alternate leaves.* But neither should too much dependence be placed upon this circumstance, in imposing specific names, or in drawing the characters of plants. Not unfrequently, the same individual has opposite leaves below, and alternate leaves above; or opposite above, and alternate below. This, indeed, is admitted by L. who gives a small list of plants, the exceptions to his general axiom.† I am persuaded, that the leaves are much less constantly opposite or alternate, even in the *same* species, than many writers have imagined.‡

In the year 1751, the celebrated nosologist, Francis Boissier Sauvages, published his *Methodus foliorum seu plantæ floræ Monspeliensis juxta foliorum ordinem.* In this work, Sauvages has attempted an arrangement of plants, from the situation or position of their leaves. But no succeeding botanist, that I know, has implicitly adopted the method of the French writer. Nor is it probable, that a method founded upon such principles will ever be adopted by genuine botanists, in pursuit of determinate characters, or in search of nature's scheme. Innumerable natural families of plants, such as the Gerania, Saxifragæ, Ranunculi, Veronicæ, not to mention the treasures which the great continent of New-Holland is pouring upon us, forbid such an arrangement. An arrangement of vegetables founded upon the resemblances or differences of their leaves, will be even much more abominable, than the arrangements of those naturalists who have associated together quadrupeds, and other mammalia, from the affinities of their teeth and claws.

B. II. Of the Anatomical structure of Leaves.

When the leaf of a plant is torn in a horizontal direction, we observe exteriorly a membrane, which is generally thin, and almost pellucid. This membrane has been called the epidermis, or scarf-skin, of the leaf. It has, with more propriety, been denominated the cortex, or bark of the leaf. This bark does not adhere to the subjacent parts with equal firmness in all plants; nor, even on the two surfaces of the leaves in the same plant. It possesses this singular property, that when you tear it off, it quickly folds itself inwards; but when it is dry, it is twisted in a contrary direction. This circumstance has induced some writers (Mr. De Saussure, at least,) to imagine, that the leaf contains two distinct systems of vessels. The pili, or hairs, which cover the surfaces of many leaves, appear to be seated in the bark. It is this part also, that is so frequently marked with white and other spots, in diseased plants. Sometimes, at least, as in the Cyclamen, or Sowbread, the disease is not deeper situated than the bark: in some plants, however, it extends further, even into the parenchymatous portion of the leaf.

* Philosophia Botanica, &c. p. 102.

† Ibid. p. 103.

‡ See the explanation of the figure of Ludvigia alternifolia.

The bark of the leaf appears to be composed of an epidermis, properly so called, and a thicker substance, which, for distinction sake, might be lenominated the cutis, or skin. It is the opinion of some physiologists, that this compound leaf-bark is a continuation of the outer and inner barks of the stem and branches, to which the leaf is attached: a supposition which seems extremely plausible, since the leaf appears to be, in fact, nothing but a kind of flat or compressed petiole, as is easily discovered by macerating a leaf and petiole in water. Now, the petiole can, in many plants, be shown to be composed of the outer and inner barks, the wood, and the medullary substance of the common trunk or stem.

The bark of the leaf is furnished with a number of glandular-like bodies, which are of different forms and sizes in different, and even in the same, species of vegetable. De Saussure has endeavoured to show, in an express work* on the bark of the leaves and petals of plants, that these organs are real glands, which perform the office of animal glands; the secretion and the preparation of the juices of the leaf. It is known, that these cortical glands are found upon both disks or surfaces of the leaves of the herbaceous vegetables: but it has been asserted, (by Mr. Bonnet,) that in the aborescent vegetables they are exclusively confined to the under surface. This, when it is considered, that between trees or shrubs and the herbaceous vegetables, nature has not placed any decided distinction, seems not at all probable. But Mr. De Saussure has shown, that these glands exist upon the upper surface of the leaves of the Juniper.

The cortical glands adhere to the beautiful net-work of which I am presently to give an account, and are surrounded by a fibre, or small vessel. Between the gland and the vessel, there is, however, an interval. The shape of the gland is that of an oval oblong: the surrounding vessel is of an eliptical form. There is an evident communication between the vessels of the cortical net and this circumambient vessel. Mr. De Saussure also observed a small and slender vessel proceeding from the extremity of the gland, and communicating with the circumambient vessel of the gland. This beautiful structure of the bark of the leaf occasions us to regret, that hitherto, we have attained to so little certain knowledge concerning the real uses of the glandular-like structure. Meanwhile, there seems to be little reason to doubt, that the glands are a necessary part of the vascular system, which is next to be mentioned.

Under the bark of the leaf, we meet with a beautiful net-work of vessels, which, whether they be arteries, veins, or absorbing lymphatics, are evidently a continuation of the vessels of the common stem, and petiole. This net-work is known by the name of the cortical net of the leaf. It is the *rete corticis* of Mr. De Saussure. It is composed of a great number of vessels, which by crossing each other, and often

* Observations sur l'ecorce des feuilles et petales. A Geneve: 1762.

anastamosing (for the language of the animal anatomists may, with strict propriety, be extended to vegetables,) form the net-like appearance of which I am speaking. The forms of the areas between the thread-like vessels composing the net are very different in different vegetables; and even in different parts of the same vegetable. These areas are more regular upon the upper than upon the under side of the leaf, and they are narrower and longer towards the petiole, or foot-stem of the leaf, than towards the middle and anterior part. Each area is commonly made up of six threads, so as sometimes to give to it an hexagonal form. More generally, however, the areas are formed by right lines.

The fibres or threads of the corticle net are, unquestionably, vessels. They are transparent, and it is highly probable, are a true system of absorbents, furnished with their proper glands. In the leaves of many plants, they are sufficiently distinct, without the aid of colouring injections: but they are seen to the greatest advantage, in many other plants, by immersing a common stem with a number of leaves, or a single leaf with its petiole, in the diluted juice of the Phytolacca decandra: or in a solution of the sulphat of iron, and then transferring them to a decoction of galls. In the former case, the cortical net assumes a fine purple colour; in the latter it is as distinctly seen, being of a dark brown or ink colour. In the leaves of the Maple, according to Ludwig, the cortical net is simple; in those of the Holly, it is double; and it appears to be triple in those of the Orange. Under the cortical net, and in the areal interstices between the vascular fibres, we meet with another substance, which has received the name of the parenchyma, the pulp, or pith of the leaf. This substance is of a tender and cellular nature, but is by no means inorganic, or destitute of vessels. On the contrary, it appears to be distinctly composed of larger vessels than those which compose the cortical net; at the same time that the areal interstices are larger than those of the net. It is this pulpy substance which is so frequently consumed by the armies of insects, which spread their hateful ravages through the gardens, the fields, and the forests of our earth. Leaving entirely, or in a great measure, untouched, the net-like work which has been mentioned, we often observe the leaves of a tree reduced, by caterpillars, and various other species of insects, to the appearance of mere dead skeletons. It is by macerating, for a considerable time, in water, the leaves of plants, and thus reducing the parenchymatous part to a more tender pulp, and afterwards expressing it out, that we form those beautiful preparations of leaves, which are so well calculated to show the fabric of the cortical net.

C. III. Of the uses of the leaves.

There is, I believe, no part or organ of the vegetable body, concerning the uses of which physiologists have been more divided in opinion, than respecting the leaves. One of the earliest opinions which seem to have been advanced by the naturalists concerning the uses of the leaves of vegetables, is that of Andreas Caesalpinus. In his work *De*

Plantis, first published in 1583, this celebrated man, to whom both natural history and medicine are indebted for the discovery or promulgation of many important truths, imagined, that the leaves were merely a kind of clothing, or a protection of the vegetable against the influence of cold and wet. The Italian Philosopher supposed, that the solar influence being weakened in its passage through the leaves, was thus prevented from acting with so much violence as it otherwise would, upon the fruit and young buds. "Accordingly, he observes, many trees lose their leaves in autumn, when their fruits are perfected, and their buds hardened, while such as retain the fruit long, keep also their leaves, even till a new crop is produced, and longer, as in the Fir, the Arbutus, and the Bay. It is reported (he adds) that in hot climates, where there is almost perpetually a burning sun, scarcely any trees lose their leaves, because they require them for shade.''

There is, unquestionably, some foundation for these observations; and, in particular, I think, for that part of the theory which ascribes to the leaves *a protecting power from the influence of the sun's rays*. It would not, however, if I mistake not, be difficult to mention a considerable number of trees which lose their leaves in, or near, the torrid zone. On the other hand, many trees and shrubs drop their leaves before the winter season, though their fruit is not yet perfected; and consequently it is exposed to all the rigours of a cold climate. This is the case with many North American Oaks, with the Franklinia Americana, the Gordonia Lasianthus, Hamamelis communis, and many others, which require an entire year to bring their fruits to perfection.*

The leaves have been considered as the perspiratory organs of the vegetable.† But Dr. Hales made an experiment which renders it very improbable, that they are *merely* perspiratory organs. This learned writer having cut off some branches of trees with apples upon them, and then stripped off the leaves, found that one apple perspired or exhaled about the same quantity of fluid as two of the leaves, the surfaces of which were nearly equal to the surface of the apple.‡ This simple experiment proved, that both the fruit and the leaves perspired: it, certainly, gave no ground for asserting, that the leaves are exclusively the organs of perspiration. The leaves have been deemed by some, the organs destined for the excretion of excrementitious juices. Dr. Hales, however, has shown, that in moist weather the leaves do not

* Some vegetables bear the loss of their leaves, by whatever means effected, tolerably well. This is especially the case with the White Mulberry (Morus alba,) the leaves of which may be repeatedly plucked by the hand, in the course of the same year: and we often see, in Pennsylvania, a third, and sometimes a fourth, crop of leaves upon our Elms, in consequence of the depredations of the pernicious little coleopterous insect, which proves so destructive to them in our streets, gardens, &c.

† J. S. Guettard, and many other writers.

‡ Statistical Essays, &c. Vol. I. p. 30.

perspire at all. It has also been observed, that "as the vapour exhaled from vegetables has no taste," this idea is not more probable than that which considers the leaves as perspiratory organs.* This, to me, does not appear to be very satisfactory reasoning. Certainly, a fluid which, to our organs, has no perceptible taste, may be noxious to, and therefore proper to be thrown out of, the body of the vegetable. But the fluid perspired by the means of many vegetables is by no means entirely tasteless; and we well know, that it is often a fluid which exerts a very decided, and even powerful, effect upon our organs of smell. These circumstances do not, however, invalidate the opinion, that the leaves are pulmonary organs. On the contrary, they even give additional weight to that opinion.

The quantity of perspirable matter which is thrown off some plants, and especially, perhaps, from their leaves, is almost incredible. Dr. Hales says the great annual Sunflower (Helianthus annuus,) that magnificent vegetable, which was cultivated by the Indians of America, from Peru to the great lakes of Canada, perspires about seventeen times as fast as the human skin, in its ordinary functions of perspiration. Another vegetable remarkable for the rapidity and greatness of its perspiration, is the beautiful Hydrangea Hortensia, now so common in the United States, where it stands even the rigours of our winters—in Pennsylvania at least. Some species of Rose also perspire very largely. But it has been thought, that hardly any plant performs the function of perspiration so extensively as the Cornus mascula, or Cornelian Cherry. According to Duhamel, the quantity of fluid which is evaporated by the leaves of this vegetable, in twenty-seven hours, is almost equal to twice the weight of the whole plant.† Is the perspiration of the North American species (which are numerous) of the genus Cornus, peculiarly great? The matter of perspiration of plants, is very various in different genera and species. Sometimes, it may be considered as a mere insipid water. We have seen this perspiration in the Weeping Willows (Salix babylonica) of Philadelphia, to such a degree, that the brick pavements have been wetted by them, as though by a shower of rain. The leaves of orange-trees sometimes perspire a saccharine matter, and so do some Solanaceous plants. Cistus creticus, of the Greek islands, perspires a resinous matter, the Labdanum of the shops, which is collected by beating the shrub by means of leather straps.‡ Dictamnus albus, called Fraxinella, exhales an inflammable vapour, which catches fire when a taper is applied to it.

The leaves, as well as the fruit of many vegetables, perspire, or perhaps more properly secrete, a waxy matter, which may easily be discovered upon their surface. The fine glaucous covering of many Plumbs, and other fruits, is certainly of this nature. The perspiration of plants,

* Dr. Darwin. † Phisique des Arbres, &c. tom i. p. 145.

‡ See Tournefort's Voyage to the Levant. English translation, vol. i. p. 79, 82. London: 1741.

like that of animals, is influenced by a variety of circumstances, a few only of which I shall mention here: viz. different conditions of the atmosphere, not only in regard to heat and cold, dryness and moisture, but also, if I mistake not, a greater or lesser degree of electricity. Plants perspire more or less, according to their state of vigour, as we daily observe in the management of our flower-pots. Lastly, the perspiration of plants is essentially increased by subjecting them to the influence of stimulating agents, such as camphor, nitre, and the like, as I have had particular occasion to observe in regard to the Liriodendron Tulipifera, &c.—See *Transactions of the American Philosophical Society*, vol. 4.

Some writers* are of opinion, that the leaves absorb a large quantity of nutriment, which is conveyed to every part of the plant. As the leaves are so abundantly supplied with vessels, which appear to be absorbents; and as the leaves of many vegetables when entirely detached from the parent grow extremely well, we can hardly doubt, that they are, in some measure, the organs of nutrition to the plant. Some ingenious philosophers have supposed, that the leaves acquire the electrical fluid from the atmosphere; whilst others, with perhaps as much propriety, have imagined, that these organs derive a certain phlogistic or inflammable principle from the light of the sun; because the leaves of so many vegetables are observed to present their upper disk or surface to the light. With respect to these two hypotheses, a very ingenious philosopher† has observed, first, "that no electricity is shewn by experiments to descend through the stems of trees, except in thunder-storms; and that if the final cause of vegetable leaves had been to conduct electricity from the air, they ought to have been gilded leaves with metallic stems:" secondly, "that if the final cause of vegetable leaves had been to absorb light, they ought to have been black and not green; as by Dr. Franklin's experiment, who laid shreds of various colours on snow in the sun-shine, the black sunk much deeper than any other colour, and consequently absorbed much more light.‡ We shall afterwards, however, have occasion to show, that light is essentially necessary to the just nourishment and complete health of the greater number of plants. It has been supposed,§ that the leaves are a kind of stomach or digestive organ to the plant; that the nutritious juices, which are absorbed by the roots, are conveyed to the leaves, where they undergo a more complete assimilation, which better befits them for the nutrition of the plant. But the function of vegetable digestion is by no means exclusively confined to the leaves; and it has not been proved, that these beautiful organs do, in fact, perform any very essential change in the obvious or intimate properties of the fluids or other matters, which are originally taken up by the roots. We are

* Hales, Lars Kullin, Dr. Adam Hunter, Dr. Priestley, &c.
† Dr. Darwin.
‡ Phytologia, &c. Sect. iv.
§ By Gustavus Bonde, Professor Ludwig, Sir John Hill, &c.

certain, that the leaves are incapable of essentially altering the taste, smell, colour and other properties of many of the bodies which their vessels absorb: and it would be rather unphilosophical to contend, that they are the digestive organs of the plant, unless we were able to prove (what has not yet been proved,) that the nutritious matters which are conveyed from the root to the leaves, are again returned by the leaves to the stem, and other parts of the body.

More probable than any of the opinions, that I have mentioned, is that which ascribes to the leaves a kind of respiratory function. This opinion, which was early adopted by some of the ingenious philosophers to whom we are indebted for much of our knowledge of the physiology of vegetables, very naturally resulted from a few simple, but conclusive experiments. Mr. Papin found, that a plant which he had put into an exhausted receiver, lived a long time, provided only the *leaves* were permitted to receive the influence of the air. But when the *whole* plant was put into the receiver, without the precaution just mentioned, it died very soon. Hence, it was sufficiently evident, that the leaves absorbed or inspired air. Moreover, it had long been known, that the leaves of vegetables were destroyed by anointing their upper surface with oil. This seemed so analogous to the effect of oil in killing insects, to which it was applied, that it was naturally inferred, that the oil operated by stopping air-vessels in the leaves, as well as in the insects. About the year 1746, Lars Kullin, a Swedish writer, endeavoured to prove, that the leaves of trees absorb the external air, and that they afterwards exhale both air and water.

L. has very expressly denominated the leaves, the lungs of vegetables.* To the great loss of natural science, both L. and Haller were taken from their labours in this world, soon after† the commencement of that brilliant era of the xviii century, when Priestley, and other illustrious men, turned their attention to the relative relations which subsist between the atmosphere and vegetables. Had the Swede and the Swiss philosophers lived a few years longer, they would, in all probability, have essentially changed some of their opinions, respecting the functions of plants and animals.

The learned and ingenious Dr. Erasmus Darwin has taken much pains to prove, that the leaves are not only the lungs of vegetables, but that the office of these leaves is extremely similar to that of the lungs of man, and many other animals. The following is the substance of the author's arguments and speculations on the subject. 1. The leaves "consist of an artery, which carries the sap to the extreme surface of the upper side of the leaf, and there exposes it under a thin moist pellicle to the action of the air; and of veins, which there collect and return it to the foot-stalk of the leaf, like the pulmonary system of animals. 2. In this organ the pellucid sap is changed to a coloured blood, like

* Philosophia Botanica, &c. p. 93.

† Haller died in 1777, and Linnæus on the eleventh of January, 1778.

the chyle in passing through the lungs of animals. 3. The leaves of aquatic plants are furnished with a larger surface, and with points like the gills of aquatic animals. 4. The upper sides of aerial leaves repel moisture, like the larynx of animals. 5. Leaves are killed by smearing them with oil, which in the same manner destroys insects, by stopping their spiracula, or the air-holes to their lungs. 6. Leaves have muscles appropriated to turn them to the light, which is necessary to their respiration. 7. To this may be added an experiment of Mr. Papin, related by Mr. Duhamel.* He put an entire plant into the exhausted receiver of an air-pump, and it soon perished; but on keeping the whole plant in this vacuum, except the leaves, which were exposed to the air, it continued to live a long time, which he adds is a proof that the leaves are the organs of respiration."† I have little hesitation in believing, that the leaves are somehow essentially concerned in the function of vegetable respiration. But I think it is far from being satisfactorily proved, that there exists in the leaf, a two-fold system of vessels, answering to the pulmonary artery and the veins of man, and other animals. I do not, however, deny, that such a system does exist in the structure of the leaf. I even think it probable that it does. I cannot, however, consider as decided the experiments which Dr. Darwin has adduced, in support of his opinion. I have made similar experiments with lactescent and other vegetable leaves, immersing them in colouring matters, such as the juice of the Phytolacca, or Poke, decoction of galls, solution of the sulphats of iron and copper, &c. In making these experiments, it was easy to perceive, that a system of vessels, which runs between the bark and the wood of the stem, enters the petiole, its continuation the middle rib, and is finally beautifully spread upon the disks or surfaces of the leaf. But I have not been able to convince myself, that the colouring matter is exclusively diffused, in the first instance, upon the *upper* disk. In some of my plants, indeed, the colouring matter was most distinctly perceived upon the superior surface of the leaf, as in Dr. Darwin's experiments with Euphorbia helioscopia, Picris, and Senecio bicolor. In other plants, however, it was sufficiently evident, that the colouring matter, after passing through the petiole, moved more especially along the lower side of the middle rib, and from this was carried through the vascular net of the leaf, nearer to the *lower* than to the upper surface of the leaf. These experiments were so frequently repeated (under a favourite impression too, that there is in plants, as well as in animals, a true circulation,) that I cannot imagine, that I have been deceived in my observation.

It must be confessed, however, that the upper surface of the leaves of vegetables, does seem admirably adapted for exposing the vegetable blood to the action of the atmosphere; and it is highly probable, that from the influence and absorption of air, or one of the component

* La Physique des Arbres, &c. Premiere Partie. p. 169, 170.

† Phytologia, &c. Sect. iv.

parts of the atmospheric mass, the Juices of the leaves do undergo some very essential and indispensible change. Perhaps, the blood of the leaf is oxygenated, or derives from the atmosphere, or from the water, in which it grows, a portion of vital air; much in the same manner that the blood of man and other land-animals is oxygenated by the vital air, which exerts its effects upon this fluid, through the medium of the lungs. The blood of man and many other animals does, unquestionably, derive its lively crimson color from the contact and absorption of vital air. It is even probable, that this vital air (so necessary to the maintainance of animal life) is the great source or foundation of the irritability of the system; since in the beautiful experiment of Charles Frederick Wolf, the attribute of irritability was first observed, in the incubated chick, at the very moment that the blood acquired its red colour.* Dr. Darwin, indeed, seems to have no doubts, that in the lactescent plants, with which he made his experiments, the milky fluid, after having been exposed to the atmosphere, upon the upper surface of the leaves, was evidently of a much whiter colour on the under surface. In the former case, as we have seen, he supposes the blood was carried, by an artery, from the petiole to the extremity of the leaf; and in the latter case, returned by a system of veins, corresponding to the pulmonary veins, from the extremity to the petiole. I have already, however, mentioned the experiments, which have compelled me to entertain some doubts as to the reality of a circulation in the leaves of plants.

Whatever may be the precise function of the leaves in the vegetable economy, it is generally agreed that a different office belongs to the upper and to the under sides of these organs. Thus, Dr. Darwin asserts, that it is the upper surface only, that respires. He justly remarks, that this surface, in many plants "strongly repels moisture," as in cabbage-leaves, where the particles of rain that lie over them, without touching them, have the appearance of globules of quicksilver. It appears, likewise, from actual experiments, that the leaves of many plants, when they were laid with their upper surfaces upon the water, withered almost as soon as in the dry air, though the same leaves, when they were placed with their under surfaces upon the water, continued green many days. These experiments, for which we are indebted to Mr. Bonnet, incontestibly proved, that with respect to the plants which were the subjects of his experiments, there was an essential difference as to the absorbing capacity of the two surfaces of the leaves: the upper surface absorbing much less than the under surface.

He put the stalks of many leaves, fresh plucked, into glass tubes filled with water, having previously covered with oil or varnish the upper surfaces of some, and the under surfaces of others. Our ingenious philosopher uniformly observed, by the sinking of the water in the tubes, that the exhalation from the under surfaces, was more than

* Theoria Generationis. 1759. 4to.

double what it was from the upper surfaces. In a supplement to his great work,* on the uses of the leaves, Bonnet has further observed, that the inferior surface of the leaves of some aquatic plants is much better adapted for the purpose of absorption than the superior surface. He made his experiments with the leaves of a species of Nymphæa, or Water-Lily. It must not be forgotten, however, in this inquiry, that Saussure has discovered upon the upper surface of the leaves of some vegetables, a system of vessels, which appeared to that judicious author to be the same as the absorbing system of the lower surfaces of other leaves. Upon the whole, there seems to be little reason to doubt, that both the upper and the under surfaces of the leaves of vegetables are furnished with their absorbing vessels; and it is highly probable, that, in many plants, air is absorbed as well by the latter as by the former of these surfaces.

I have already intimated that the office of the leaves, is a varied and a complex one. Dr. Hales was of the same opinion, a long time ago. In his *Statical Essays*, he does not hesitate to consider the leaves as the vegetable organs of nutrition, respiration, perspiration, and excretion. The experiments of Hales render it probable, that thus various are the functions of the leaves. I am persuaded, that future experiments will decidedly prove, that the leaves are not merely the lungs and perspiratory organs of the vegetable.

D. IV. Miscellaneous circumstances relative to the natural history of leaves.

1. More than twenty-five thousand species of vegetables are now known to the botanists, and of this number a very large proportion is furnished with leaves. None of the trees, strictly so called, are destitute of these beautiful parts. Some vegetables, however, are leafless. Such are the two species of Ephedra,† or Shrubby Horse-tail, and the great family of Fungous plants. These last have many of the habitudes of animals, and even the circumstance of their being leafless vegetables is one in the series of their relations to that vast empire of organized bodies.

2. The leaves of certain vegetables acquire a very great size. It is curious, too, to remark, that it is only in the hot or hottest portions of the globe, that we find the largest leaves. I believe that the cold climates, and even those which are moderately warm, do not furnish us with any instances of very large-leaved trees. It does seem, that the magnitude of the leaves of certain species of trees, increases as we approach the line.‡ In the cold climates, we find no Palms, with leaves so large as to be capable of sheltering whole families from the incle-

* Recherches sur l'usage des feuilles dans les plantes, &c. A Gottingue & Leide: 1754. 4to.

† Ephedra distachya, and Ephedra monostachya. The first species is a native of the south of France, and of Spain: the latter is a native of Siberia.

‡ The amiable Bernardin De Saint Pierre.

mency of the weather.* Why should we doubt, (when a vast system of benevolence is so conspicuous in this earth), that in giving to the vegetables of hot climates such capacious leaves, the Author of the universe had consulted the health, the comforts, and the pleasures of the human inhabitants, destined to live beneath the scorching rays of the sun ? But man is not the only animal that derives advantages from the large spreading leaves of tropical trees. The birds and many other animals are equally benefitted. Destitute of this shelter, many species would be nearly incapable of subsisting in the countries in which they reside; and, in particular, they would be incapable (unless their instinctive operations were essentially varied) of rearing their young.

3. The precise time of the year and month in which any given species of vegetable unfolds its first leaves is denominated, by L., *Frondescentia*.† To this subject, the Swedish naturalist has paid much attention. He made a great number of observations, in eighteen different provinces of his native country, situated between the sixtieth and seventieth degree of north latitude, in the years 1750, 1751, and 1752. It was his object to discover, which species of trees begin to open their buds, and unfold their leaves, at the most proper time for the sowing of Barley. The result of his inquiries was, that the Birch-tree (Betula Alnus) gave the most proper indication for this purpose. He justly imagined, that in every province of Europe, there exist other trees, which will, in like manner, indicate the proper time for sowing grains of different kinds, and also esculent herbs. This is, certainly, a subject worthy of the attention of naturalists, whose inquiries are directed to utility. Much important information would result from an extensive investigation of the subject. The agricultural rules of savage nations are frequently founded, in a great measure, upon the frondescence, together with the time of flowering, of different vegetables, indigenous in their countries. Thus, the Indians, in different parts of North America, are of opinion, that the best time for planting the Maize, or Indian-corn, is when the leaves of the White-Oak‡ first make their appearance; or rather, as they express it, when the leaves of this common tree are of the size of a §squirrel's ears. I shall have occasion to touch again on this subject, when treating of the *Calendarium Floræ*, or Calender of *Flora*. 4 By the term *Defoliatio*,|| or Defoliation, L. means the season of the year at which the vegetables of any particular country shed their leaves. Thus, this term is directly opposed to that

* One of the largest leaves that are known to us is that of the Talipot (Corypha umbraculifera ?) a native of Ceylon. Robert Knox assures us that a single leaf is capable of covering from fifteen to twenty persons. He considers the Talipot as one of the greatest blessings that Providence has bestowed upon the inhabitants of a country, which is parched by the sun, and inundated by the rains, for six months in the year.

† From *Frons*, a leaf. ‡ Quercus alba.

§ Sciurus cinereus, the most common species of squirrel in North America.

|| From *de*, and *Folium*, a leaf.

of frondescentia. With respect to the defoliation of vegetables, it is proper to observe, that the same species does not always drop its leaves at the same time, even in the same district of a country; but, in particular, that the same species sheds its leaves at very different periods, in different countries. In both instances, the difference of the time of defoliation seems to depend, principally, upon a difference of season, or of climate. Extreme heat and extreme cold are both observed to be favourable to the fall of the leaf. In the hot summers, the leaves of many plants lose their verdure, and fall a full month earlier than they do in milder seasons. 5. The fall of the leaf is almost always preceded by a very essential change in its colour. Yellow, red, and brown are the most common colours of the dying leaf. About the close of September (sooner or later according to the season), the forest-trees in Pennsylvania, and other middle parts of the United States, begin to lose their verdure. The leaves assume new colours, particularly yellow and red, or crimson. Nothing can be more picturesque than an American forest, at this season. The beauties of the scenery will be described by some future Thompson; or exhibited on canvass by the pencil of an American Salvator Rosa. It will be sufficient for me to observe, that the leaves of almost all the species of Juglans (Walnuts and Hickory) and Maple, assume different shades of yellow; whilst those of Nyssa integrifolia, called Gum, the Laurus Sassafras, the Cornus florida, or Dogwood, and others, are clothed in a livery of crimson, or red. 6. Some vegetables do not drop their leaves at all, during the whole year. Their verdure is not, in the least, injured by the changes of the weather. The Fir, the Juniper, the Yew, the Cypress, the Kalmiæ, and many others, belong to this class of Evergreens, as they are very emphatically called. In general, the leaves of the evergreens are harder and less succulent than those of deciduous vegetables. It is observable, also, that their surfaces are covered by a very thin, parchment-like cortex, or bark. It is found, that they perspire less than the leaves of deciduous vegetables. Some writers have, accordingly, conjectured, that the sempervirent quality of these vegetables is owing to the smallness of their perspiration. Dr. Arbuthnot imagined, that the verdurous quality was owing to the leaves containing more juices than can be exhaled by the sun. The celebrated Dr. Grew supposed, that a thick epidermis, dense cellular substance, and few tracheæ, or spiral-vessels, are the true cause of the perpetual verdure of these vegetables. Duhamel thought, that this state of the vegetable depended upon a hard knot, at the base of the leaves. Others, again, have supposed, that a gummy matter, residing within the vegetables, is the cause of the lasting verdure. But if this were the case, we should find, that Cherry-trees, Plumb-trees, Peach-trees, and other vegetables that abound in gum, would be evergreens also. Perhaps, none of these explanations of the cause of the evergreen quality of leaves is wholly satisfactory. The circumstance seems principally referable to climate. The same species is a perdifoil, or drops its leaves, in one

climate, and preserves them in another. Thus, the Passion-flower* of America, and the Jasmine of Malabar†, are evergreens in their native climates, but become perdifoils when they are transplanted into Britain, and other northern parts of Europe, On the other hand, many of the perdifoils of cold climates, when transplanted to warmer climates, become evergreens. Thus, the Quince-tree is a perdifoil in northern countries, but becomes an evergreen when transplanted to the south of France, the island of Minorca, and other southern climates. I am assured, that the Currant-bushes which were sent from Britain, where they are deciduous, to the Island of St. Helena, became, in a short time, evergreens, but ceased to bear fruit. Professor Thunberg informs us, that the Oak (Quercus Robur,) the White Poplar (Populus alba,) and other trees which were imported from Europe to the Cape of Good-Hope, "shed their leaves in the winter, as they do in their native places, whereas the African trees do not part with theirs. It is not long, however, (continues our author,) before they recover their leaves again. This circumstance is singular enough: first, because the cold here (at the Cape of Good Hope) in winter is not more severe than it is in Sweden in the autumn; and in the second place, because they shed their leaves to the southward of the equator at the very time that they put them forth to the northward of it."‡

The various colours which the leaves of vegetables assume in the autumn, prior to their fall, have been supposed by some eminent chemists, to depend upon the absorption of oxygen. How far is this hypothesis well founded? Are the autumnal colours of the same species of vegetable, inhabiting different portions of the globe, in nearly the same parallel of latitude, the same? Laurus Sassafras is said to inhabit Cochinchina; Juglans nigra and Bignonia Catalpa, Japan. It has been very justly observed, that some vegetables are by their very nature, or the structure of their parts, perdifoils, or deciduous. This is the case with the two species of Platanus, or Plane-tree, that are now known to us. Thus in the Platanus occidentalis, one of the most majestic and common of the North American trees, the buds are concealed in the end of the petiole, and as they increase in size, they unavoidably force off the leaf, the petiole of which is now dilated at its origin, assuming a funnel-like appearance. In this funnel or cavity, the bud was concealed. This Platanus (called in the United States Buttonwood, or B. tree, Sycamore, and Water-Beach) is by this structure of its buds, absolutely a perdifoil. The leaves fall off in the latter end of October, at which time we sometimes find the cavity at the end of the petiole, large enough to admit the end of the little finger; and it is almost impossible to see a single leaf remaining upon any of these trees in the winter season. The same structure of the petiole occurs in other

* Passiflora coerulea. † Jasminum grandiflorum.

‡ Travels in Europe, Africa, and Asia, &c. Vol. I. p. 104. English translation. London : 1796.

vegetables, which, for the same reason, are perdifoils; such as the Virgilia, or Yellow-wood, a tree of Tennessee, and other western parts of North America. In different species of Rhus, or Sumach, the fall of the leaf is not so determinate, though here also the nascent bud presses upon the petiole. But in the Sumach, the pressure of the bud is oblique; and consequently, the petiole is not so readily forced off.

7. Mr. Bruce informs us, that all the leaves of the trees in Abyssinia, are very highly varnished, and of a tough, leather-like texture, which enables them to support the constant and violent rains, under which these trees are produced.* This is a wise provision of nature. But in what, the highest or the lowest object, is not thy wisdom, Nature, conspicuous?

III. Of the *Fulcra*, the third general part of the herb.

The fulcra, or fulcres, are defined by L. to be helps of the plant, for its more commodious sustentation, or support. At different times, he enumerated a very different number. In the *Fundamenta Botanica*, published in 1736, they were six, and stood in the following order, viz. *Bractea*, *Cirrhus*, *Spina*, *Aculeus*, *Stipula*, and *Glandula*. In a subsequent edition of the same work, he enumerated nine fulcres, the three additional to those just mentioned, being the *Scapus*, the *Petiolus*, and the *Pedunculus*, which he had formerly considered as species of trunks. In his immortal work, the *Philosophia Botanica*, published in 1750, we find but seven species enumeratad: viz. *Stipula*, *Bractea*, *Spina*, *Aculeus*, *Cirrhus*, *Glandula*, and *Pilus*. In the *Termini Botanici*, published in the *Amoenitates Academicæ*,† by John Elmgren, one of the pupils of the great naturalist, and in the *Delineatio Plantæ*, which is prefixed to the second volume of the *Systemæ Naturæ*, the fulcres were to experience one more revolution. In these works, the terms *Aculeus* and *Spina* give way to the general term of *Arma;* and *Pilus* is supplanted by the less delicate, and less determinate, term *Pubes*, by which L. means every species of pubescence, or hairy appearance, on the surface of plants. *Glandula* also is swallowed up in *Pubes*, and the partial trunks, *Petiolus* and *Pedunculus*, are again to appear among the fulcres. The list now stood as follows, viz. *Petiolus*, *Stipulæ*, *Cirrhus*, *Pubes*, *Arma*, *Bracteæ*, *Pedunculus*.

I find it not a little difficult to satisfy my mind, as to the parts of the plant which ought to be introduced under this general head of fulcres. I do not think the science of Botany would lose much of its value, by the entire abolition of the term. Certain it is, that several of the articles enumerated by L. cannot, with any degree of propriety, be considered as props, for the more commodious sustentation of the plant. Upon what principle, can we denominate the spina, the aculeus, the glandula, and the pilus, species of props? Perhaps, bractea and stipula

* Travels, &c. Appendix. p. 151, 152. Quarto edition.
† Vol. VI. Dissertatio CXIII.

have not a much higher claim to this title. But I dare not think of abolishing a term, sanctioned by the authority of so many able botanists; though one* of the most distinguished of them has confessed, that the term is rather "forced." I shall treat, under the head of fulcres, of the following parts of the plant, viz. 1. *Petiolus.* 2. *Pedunculus.* 3. *Cirrus.* 4. *Stipula.* 5. *Bractea.* 6. *Spina.* 7. *Aculeus.* 8. *Glandula.* 9. *Pilus.*

I. The Petiolus,† or Petiole, called also the Leaf-stalk, or Foot-stalk, is a fulcre supporting the leaf. I have had frequent occasion to make mention of this part, in the preceding pages. I have observed, that L., at different times, considered it as a species of trunk. But if the name fulcre must be retained, I think we may be glad to have an opportunity of referring to this head, both the petiole and peduncle. I am aware, that this is not the language of all botanists. Thus, Dr. Milne is of opinion, that neither the petiole nor the peduncle have been, with propriety, enumerated among the fulcres, "with which (says this often judicious writer) they have no connexion."‡

In the generality of plants, the petiole is nearly of the same colour as the leaf to which it belongs. Indeed, it appears to be nothing but the leaf in a compressed state. The evolution of the leaf from the petiole is very distinctly observed in the Sallisburia adiantifolia or Ginko.§ The petiole of many plants is nearly cylindrical; it is, however, more commonly somewhat compressed, its upper surface, at least, being flatted; the under round or convex. "By this configuration, the footstalks of compound leaves are generally, with accuracy, distinguished from the young branches, with which beginners are very apt to confound them."‖ In the greater number of vegetables, the leaves and the fructification are supported by distinct footstalks. In a few plants, however, the same footstalk supports both the leaf and the flower, or the fruit. This is the case in Turnera ulmifolia, and in Hibiscus Moscheutos, or Syrian Mallow. The petiole sometimes supplies us with very elegant marks for discriminating the different species of a genus. The *petiolus alatus*, or winged petiole, is a species of leaf-footstalk, which has a thin membrane or border, on each side of it. This little character distinguishes the Orange (Citrus Aurantium,) from the Lemon (Citrus Medici.) In the latter species, the petiole is linear, that is nearly of the same breadth its whole length. This is the *petiolus linearis* of L.

2. The Pedunculus,¶ or Peduncle, is a partial stem, or trunk, which supports the fructification, without the leaves. I think it most proper

* Dr. James Edward Smith.

† By the Roman writers, the term petiolus was employed to denote the footstalk of the fruit. In this sense, it is used by Columella.

‡ A Botanical Dictionary, &c. article Fulcra.

§ The Maiden-hair tree, a native of Japan. ‖ Milne.

¶ Mr. Ray, and other of the older botanists use *Pediculus*, instead of Pedunculus. The former is, certainly, the more classical name. It is sanctioned by Pliny, the naturalist, and other good writers.

to treat of it, in this place, among the number of fulcres. Professor Martyn properly calls it "the fulcre of the fructification."

The principal species or varieties of the peduncle enumerated by L., are now to be mentioned.

a. With respect to its place of origin, a peduncle is 1. *radicalis*, a root peduncle; proceeding immediately from the root. 2. *caulinus*, a stem peduncle; proceeding from the stem. 3. *rameus*, a branch peduncle; proceeding from a branch. 4. *petiolaris*, petiolary; proceeding from the petiole. 5. *cirrhiferus*, or tendril bearing. 6. *terminalis*, terminating, or proceeding from the top of the stem. 7. *axillaris*, axillary, proceeding from the axil, or angle, which is made by the leaf and the stem, or the branch and stem. 8. *oppositifolius*, opposite to a leaf. 9. *lateriflorus*, having the flower on the side of it. 10. *interfoliaceus*, among the leaves: perhaps, *intrafoliaceus*, within the leaf. 11. *extrafoliaceus*, without, or on the outside of the leaf. 12. *suprafoliaceus*, inserted into the stem, higher than the leaf, or than its petiole.

b. With respect to their situation, peduncles may be, 1. *oppositi*, opposite to each other, or, 2. *alterni*, alternate. 3. *sparsi*, scattered, without any regular order. 4. *verticillati*, in whorls.

c. With respect to their number, peduncles may be 1. *solitarii*, solitary, or single. 2. *geminati*, double, two together, or in pairs. In the umbellula, umbellule, or rundlet, several equal peduncles proceed or diverge from the same centre, or point. The peduncle, according to the number of flowers which it bears, is denominated, 1. *uniflorus*. 2. *biflorus*, 3. *triflorus*, &c. 4. *multiflorus*, that is, one, two, three-flowered, and many-flowered.

d. With respect to its direction, a peduncle may be, 1. *appressus*, pressed close to the stem. 2. *erectus*, upright. 3. *patens*, spreading. 4. *cernuus*, drooping, or pointing to the ground. 5. *resupinatus*, upside down. 6. *declinatus*, bowed, or curved downwards. 7. *nutans*, nodding, or curved downwards, more so than in the last mentioned, but less so than in the drooping peduncle. 8. *adscendens*, rising gradually. 9. *flaccidus*, weak or feeble, bending with the weight of the flower, which it supports. 10. *pendulus*, loose, tending downward with the leaf. 11. *strictus*, stiff and straight. 12. *flexuosus*, bending readily, in different directions. 13. *retrofractus*, bent backwards, as if broken.

e. With respect to its measure, a peduncle is, 1. *brevis*, short. 2. *brevissimus*, very short. 3. *longus*, long. 4. *longissimus*, very long.

f. With respect to its structure, a peduncle is, 1. *teres*, round, cylindrical, or perhaps rather columnar. 2. *triqueter*, three-sided. 3. *tetragonus*, four-cornered. 4. *filiformis*, like a thread, or of the same thickness in all its parts. 5. *attenuatus*, tapering gradually towards the top. 6. *incrassatus*, growing gradually thicker towards the top. 7. *clavatus*, club-shaped; or thick at the end. 8. *nudus*, naked. 9. *squamosus*, scaly. 10. *foliatus*, leafy. 11. *bracteatus*, furnished with bracteæ, or bractes. 12. *geniculatus*, kneed, or bent at the joints; and, 13. *articulatus*, jointed.

The Cirrus,* or Tendril, called also Clasper, is a fine spiral string, or fibre, proceeding from different parts of the plant, and by means of which it fastens itself to some other plant or body. The term cirrus is synonimous to the terms of Capreolus, Clavicula, and Viticulus of the older botanists.

The various species of tendrils mentioned by L. I shall notice under two heads: first, according to their place of origin, or situation; secondly, according to their form, or the number of leaves which they support.

1. To the first head, we refer the following: viz. 1. *cirrus axillaris*, when the tendril proceeds from the axil, or angle formed by a branch with the stem, or by a leaf with a branch. 2. *cirrus foliaris*, proceeding from the leaf; as in the Pisum Ochrus, or Winged-Pea. 3. *cirrus petiolaris*, proceeding from the petiole, or footstalk of the leaf. 4. *cirrus peduncularis*, from the peduncle.

2. To the second head belong the following, viz. 1. *cirrus simplex*, a simple or undivided tendril. 2. *cirrus trifidus*, a three-cleft tendril; a tendril divided into three parts. 3. *cirrus multifidus*, many-cleft, or often divided. 4. *cirrus diphyllus*, a two-leaved tendril; furnished with two leaves. 5. *cirrus tetraphyllus*, a four-leaved tendril; having four leaves 6. *cirrus polyphyllus*, a many-leaved tendril; having many leaves. 7. *cirrus convolutus*, a convoluted tendril; twisted into rings, or spirals. 8. *cirrus revolutus*, a revolute tendril; when a spire of the screw having made half a revolution, turns back in a contrary direction.†

Tendrils are a very important appendage to many vegetables. The Solanum Dulcamara, Bignonia radicans, called Trumpet-flower, and some species of Hedera, or Ivy, emit tendrils, which serve the place of roots, planting themselves into the bark of trees, or in the walls of buildings. In the Cucumber, and other cucurbitaceous plants, the tendrils serve both for sustentation, and for shade. By means of these parts, the trunks of the plants are bound, as it were, together, and prevented from being at the sport of the winds. "The same claspers serve likewise for shade: so that a natural arbour is formed by the branches of the Cucumber, in the same manner as an artificial one is made by tangling together the twigs of trees; for the branches, by the linking of their claspers, being couched together, the tender fruits lie under the umbrage of a bower, made of their own leaves.‡

* L. writes the word Cirrhus, which is less proper, not sanctioned, as far as I know, by any good or classical writer. Martial, Phædrus, Pliny, &c. write it cirrus. The Latin word signifies a tuft, or lock of hair curled, a curl or frizzle, &c. The Greek original of the word is so doubtful, that I shall not notice the discordant opinions of authors on the subject.

† For a representation of the cirrus, or tendril, see the plate of Passiflora incarnata, in this work.

‡ Milne.

Many of the papilionaceous or pea-blossom plants have twining tendrils, which wind to the right and back again. Many extensive families of plants are entirely destitute of tendrils. Philips has given a kind of instinctive perception to some of the tendril-vegetables, as appears from the following lines in his poem, entitled Cyder.

————"The Gourd,
And thirsty Cucumber, when they perceive
Th' approaching Olive, with resentment fly
Her fatty fibres, and with Tendrils creep
Diverse, detesting contact."—Book I. l. 257—261.

I shall afterwards have occasion to observe, that it is among some of the vegetables that are furnished with tendrils, that we discover the most remarkable instances of that property, which has been called the perceptivity, or instinctive intelligence, of plants.

4. The Stipula,* or Stipule, is defined by L. to be a scale, or small leaf, situated on each side of the base of the petiole and peduncle, or footstalks of the leaves and flowers, at their first appearance, and are designed for the purpose of sustentation, or support. L.'s pupil, Elmgren, whose paper I have already referred to, restricts the term stipule to the petiole only.

The celebrated Malpighi, who may justly be stiled one of the fathers of vegetable physiology, was, I believe, the first person who gave to the public any observations concerning the number, the figure, and the situation of this part of the plant. L. borrowing the hint, has greatly improved upon the observations of the illustrious Italian naturalist. In particular, he has made much important use of the stipule in discriminating the different species of a genus, or family of plants. Stipules are very conspicuous in the Tamarind, the Rose, the Cassia, the Melianthus, or Honey-flower, the Apricot, the Peach, the Bird-Cherry, the Magnolia, and many species of Pea-bloom flowers, &c. Perhaps, in no plant are they more beautifully conspicuous than in the Liriodendron, or Tulip-tree. In this and in some other vegetables, stipules may, with some propriety, be said to be fulcres, or supports. They enclose, protect, and cherish the young leaves, until they have acquired a larger growth, and greater strength. But, in many plants, the stipules appear to have nothing to do in the business of giving support. In the greater number of plants, that are furnished with stipules, there are two of these scales or leaves, attached to the stem, one on each side of the footstalk. These are the *stipulæ geminæ*, or stipules in pairs. In the African Melianthus, and in the Ruscus, or Butcher's broom, there is only a single stipule, which in the first mentioned plant is placed on the inside, and in the latter on the outside, of the stalk. Such stipules

*Stipula, the diminutive of *Stipa*, tow; originally from στυπη, which also signifies tow.

are called by L. *solitariæ,* solitary. In some plants, the stipules grow upon, or are inserted into, the sides. These are the *stipulæ laterales,* or lateral stipules. *Stipulæ extrafoliaceæ,* or extrafoliaceous stipules, are those which grow on the outside of the leaves, or below them; as in Betula, Tilia, and many of the Diadelphous, or Pea-bloom-flowers. This term is opposed to *stipulæ intrafoliaceæ,* or intrafoliaceous stipules; that grow above, or within the leaves. *Stipulæ oppositifoliæ,* or oppositifolious stipules, are such as are placed opposite to the leaf.

In point of duration, some stipules fall off before the leaves. These are the, 1. *stipulæ caducæ,* or caducous stipules. We have examples of them in the common Cherry-tree, the Almond, the Poplar, the Elm, the Oak, the Beech, the Horn-Beam, the Birch, the Alder, the Fig, the Mulberry, and many others. Other stipules are deciduous: these L. denominates, 2. *stipulæ deciduæ,* or deciduous stipules: they are those which fall off with the flower. 3. *stipulæ persistentes,* or permanent stipules, are those which continue until the fall of the leaves; as in the Rose, the Rasberry, the Cinquefoil, the Tormentil, the Avens, the Pea-bloom-flowers, and many others. The terms sessile, adnate, decurrent, sheathing, subulate, lanceolate, sagittate, lunate, erect, spreading, reflex, very entire, serrate, ciliate, toothed, cleft, very short, middling short, long, &c. &c. are applied to stipules, as well as to leaves.

5. The Bractea,* Bracte, or Floral-leaf which, in general, differs from the true leaves both in shape and in colour, and is commonly situated on the peduncle, and often so near to the corolla as to be mistaken for the calyx. This is the case in Hellebore, Nigella, Bartsia, Peganum, and others. The following, among other plants, furnish us with the most remarkable instances of the bracte, viz. the Tilia, or Lime-tree, Melampyrum, or Cow-wheat, Bartsia coccinea,† some species of Fumaria, or Fumitory, the Monarda didyma, or Oswego-tea, Polygala, or Milk-wort, Ononis, or Rest-harrow, Anthyllis, or Lady's finger, Glycine frutescens, or Carolina Kidney-bean tree, &c. &c. In general, the bracte is of the same duration as the common or true leaves of the plant. This circumstance is worthy of attention, as it will, in some instances, enable us to distinguish the bracte from the perianth, or flower-cup, which last almost always withers when the fruit has ripened, if not, indeed, before. By not attending to this observation, the young or inexperienced botanist may very readily commit essential

* Bractea, in Latin, has the following significations, viz. a thin leaf, or plate of gold, silver, or any other metal; a tinsel, a spangle, a chip or thin piece of wood; a weather-cock upon the summit of steeples, turrets, &c. Hence it appears, that L. has not discovered much taste in applying this name to the floral leaf. With respect to the English word, bracte, I should substitute in its place, floral-leaves, were it not that this term is frequently employed by L. to denote leaves which are situated near the flower, when they differ from the other leaves, though they are not, strictly speaking, bractes.

† See Plate IV.

mistakes, in ascertaining the genera of certain plants; such as Hellebore, Fennel-flower, Passion-flower, and others, which are furnished with bractes; but are destitute of calyx: at least according to the ideas of L. respecting the calyx; for I shall afterwards have occasion to observe, that Jussieu, Adanson, and other eminent botanists, often give the name of calyx, to that part which L. calls the corolla, or petals.

a. Bractes are either, 1. *virides*, green, or, 2. *coloratæ*, coloured. They are green in Hypoxis erecta, and beautifully coloured in Bartsia coccinea.*

b. In point of duration, they are either, 1. *deciduæ*, deciduous. 2. *caducæ*, caducous. 3. *persistentes*, permanent. These terms have already been explained.

c. In point of number, bractes are either, 1. *una*, one. 2. *duæ*, two. 3. *plures*, more than two. The following, among other plants, have, in general, but one bracte: viz. Chondrilla juncea, Aristolochia Pistolochia, and Erica Dabœcia. The following plants have two bractes: viz. Campanula alpina, Commelina Zanonia, Rosa canina, Royena villosa, Ruellia ringens, Cineraria sibirica, and Hypoxis erecta.† Erica calycina, and Atractylis cancellata have three bractes. Corymbium scabrum has four or five. Cunila pulegioides, Stipa spinifex, Bartsia coccinea, and many others, have several bractes.

d. In respect to size and height, bractes are, 1. shorter than the calyx, as in Justicia hyssopifolia, and Ruellia ringens. 2. longer than the calyx, as in Salvia Selarea, Ruellia repens, and Stipa spinifex. 3. larger than the calyx, and placed under it, as in Royena villosa. 4. shorter than the flower, as in Salvia sylvestris, Fumaria nobilis, and Minuartia campestris. 5. of equal length with the flower, in Fumaria bulbosa, Hypoxis erecta, Ornithogalum comosum, and, 6. longer than the flower, as in Ribes alpina, and Minuartia montana. 7. Cunila pulegioides, called, in the United-States, Penny-Royal, &c. besides a number of smaller bractes, has two that are larger than the flower, placed on each side of the footstalk.

e. In some plants, such as Crown-Imperial, Lavender, certain species of Sage, Bartsia coccinea, and a few others, the stem is terminated by a number of very large and conspicuous bractes, which are denominated *Coma*,‡ and *Bracteæ comosæ*, from their resemblance to a bush or bunch of hair. In discriminating the species of plants, bractes, particularly those of the bushy kind just mentioned, are of essential consequence. The real use of the bracte, in the vegetable economy, does not appear to be completely ascertained. In many vegetables, indeed, this part is so very inconsiderable in size, and so similar to minute squamæ or scales, which, in other parts of the plant, have not seemed to merit any attention, and have not received a name, that it appears

* See Plate IV.

† See Plate XIII. Fig. 1. Hypoxis has often more than two bractes.

‡ *Coma*, from [illegible], a head of hair.

that such minute bractes are of no very indispensible consequence. But in other plants, the bracte is a part large, conspicuous, and seems to answer some important purpose. Dr. Darwin conjectures, that the bractes, or floral leaves, "supply an organ of respiration to the calyx and pericarp of the flower-bud." All the different kinds of bractes, according to this multifarious genius, "serve the office of lungs, for the purpose of exposing the vegetable blood to the influence of the air, and of preparing it for the secretion, or production and nourishment of the vegetable, uterus, or pericarp, and of the seeds produced and retained in it, frequently before their impregnation, and always after it." Dr. Darwin observes, that in many plants, "bractes do not appear till after the corol and nectaries, with the anthers and stigmas, drop off; that is, not till after the seed is impregnated, as in Colchicum autumnale, Crocus, Hamamelis, and in some fruit-trees. The production of the vegetable uterus, or pericarp, with the unimpregnated seeds included in it, is (our author asserts) in these plants accomplished or evolved, like the bractes themselves, with the corol and sexual organs, by the sap-juice, forced up in the umbilical vessels from some previously prepared reservoir, without the necessity of any exposition to the air in leaves or lungs, which are not yet formed, though it may acquire oxygenation in the fine arteries of the embryon buds, which are supposed to surround the horizontal air-vessels, observed in the bark of trees. As soon as the seeds become impregnated, the corol and nectaries with the sexual organs fall off, and the pericarp and its contained seeds are then nourished by the blood, which is aerated or oxygenated in the bractes, or floral leaves. Thus the flower of the Colchicum appears in autumn without any green leaves, and the pericarp with its impregnated seeds, rises out of the ground, in the ensuing spring, on a stem surrounded with bractes, and with other green leaves below them, which produce new bulbs in their bosoms." Dr. Darwin is of opinion, that the blood which supplies nourishment to the pericarp and the seeds which it contains, "does not seem to require so much oxygenation as that which supplies nutriment to the embryon buds; whence (he remarks) the floral leaves are, in general, much less than the root-leaves in many plants, and than the common green leaves of almost all vegetables."*

6. The Spina, Spine, or Thorn, is a sharp process from the ligneous, or woody part of the plant, and is said to serve for its defence. We have instances of this in many plants, such as Prunus, Cratægus, Gleditsia, &c. Spines are protruded from the stem and branches, as in Buck-thorn, Pear, Plum, and Orange trees; from the petioles, as in Robinia Pseud-Acacia, called Locust in the United-States; from the leaves themselves, as in Aloë; Agave americana, or American Aloë; Yucca filamentosa, or Adam's needle; Holly; Manchineel (Hippomane Mancinella,) Butcher's broom, &c. from the ribs of the leaves, as in several species of Nightshade: from the calyx, as in

* Phytologia, &c. Sect. IV.

Thistle; from the seed-vessel, or pericarp, as in Datura Stramonium, or Thorn-apple, &c. &c.

Thorns are either terminating, that is, placed at the end of a branch or leaf, or axillary, proceeding from the angle, which is formed by a branch or leaf with the stem. The first is the *spina terminalis*, and the last, the *spina axillaris*, of L. Thorns are either simple, as in the greater number of thorny plants; double as in Horned Acacia; or triple, as in the Honey-locust of the United States, which, on account of the number of its thorns, is called Gleditsia tricanthos. It must not, however, be supposed, that the number of thorns, growing together, in the same species, is always the same: for in the Gleditsia, although the number is, in general, three, there is sometimes only one; sometimes there are two, sometimes five or six.

According to Mr. Willdenow, the thorn "arises most generally from an incompletely evolved bud, which has began to form itself, but wanting a proper supply of nourishment, remains only in form of a very short, sharp, and bare twig. It is, like the woody stem of a tree or shrub, formed of the air and adducent vessels, which have grown completely hard. It therefore remains fixed, though the bark be taken off." *Principles*, &c. pp. 270, 271. We often see one or more leaves proceeding from a firm and rigid thorn; which, in process of time, becomes a flowering branch. Some plants, however, hardly ever part with their thorns entirely: such as Buckthorn. And I have not yet learned, that the rigid thorn of Gleditsia triacanthos ever becomes a frondose stem. Cultivation never converts a prickle into a shoot.

7. The Aculeus,* or Prickle, is a sharp process from a plant, arising from the bark only, and not from the wood. In this respect, it differs essentially from the spina, or thorn, which is a prolongation of the woody part of the vegetable, to which it belongs. The difference of the origin of these two species of armature is very apparent, from the facility with which the prickle is detached, the bark merely coming away with it, and not the wood; whereas the thorn is not removed, without, at the same time, removing a portion of the wood. Owing to this difference of origin, prickles are less rigid than thorns. The Rose, the Raspberry, the Berberry, the Aralia spinosa, called Angelica-tree, the Currant, and other bushes or vegetables, furnish us with familiar examples of the prickle.

Prickles are either 1. *recti*, straight; as in the Solanum indicum. 2. *incurvi*, bent inwards; as in Mimosa cineraria; 3. *recurvi*, recurved, or bent outwards. 4. *tomentosi*, downy; or covered with a silver-white woolly appearance; as in Solanum sanctum. 5. *acerosi*, chaffy; as in Solanum tomentosum. 6. *geminati*, double; or two growing together; as in Euphorbia canariensis, and in Euphorbia officinarum. Prickles, when divided, are named, *furcæ*, forks, or forked prickles; and are called bifid, trifid, &c., from the number of their divisions. We appear to

* Aculeus, from *Acus*, a needle.

be rather better acquainted with the final intention of nature in forming thorns and prickles, than some of the other parts of vegetables. These two species of armature seem to have been bestowed upon vegetables, in some measure, for the purposes of defence, against the injuries of animals. But that this is the *sole* use of the prickle and the thorn, many circumstances are calculated to render doubtful. Numerous vegetables, upon which various species of animals commit great ravages, are destitute both of spines and prickles; and, on the other hand, there are not a few instances of vegetables, which are carefully guarded with these armatures, although their poisonous or other quality is sufficient to secure them from injuries. Culture exerts a decided effect upon both the spines and prickles of vegetables. The branches of the Pear, the Orange, the Citron, the Lemon, the Medlar, the Hawthorn, the Gooseberry-bush, not to mention others, when taken under the fostering care of the gardener, often lose their spines. This shows how great are the effects of culture upon vegetables: perhaps, it even shows that the spine and the prickle were intended for the purpose which has been mentioned; since vegetables so frequently lose their armature, when they are transferred to the soil that is tilled by man, who will guard, with interested attention, these plants from the depredations of animals.

8. The Glandula, Gland, or Glandule, is said to be a kind of secretory or excretory vessel, which is found upon the surface of many vegetables. In his *Philosophia Botanica*, L. defines it to be a papilla excreting a fluid or humour.* In the *Delineatio Plantæ*, he defines it a fulcre secreting a liquor.† This last definition is unmeaning, and intolerable. Glands are found upon almost every part of the surface of different plants. They assume a great variety of appearances. Sometimes they resemble a blister or bladder, as in St. John's-wort; sometimes a number of scales, as in many Ferns; sometimes small grains, not unlike those of Millet, as in Fir-tree; sometimes a small cup, as in the Apricot-tree. In many instances, glands are furnished with their proper footstalks: often they are situated upon the leaves of plants, without any footstalks. In the following plants, glands are situated on the petioles, or footstalks of the leaves, viz. Ricinus communis, Cassava, Passion-flower, different species of Cassia,‡ and Robinia. They are seated on the indented or sawed edges of the leaves in the Willow-tree. In the Almond-tree, the Gourd, the Gelder-Rose, and the Bird-Cherry they proceed from the base of the leaf. In the Urena, Tamarisk, Bastard Ricinus, and others, they spring from its back; whilst in the Butter-wort, and Sundew, they come out from its upper surface. In some plants, as in Mountain Ebony,§ and Apricot-tree, the glands are situated upon the tender stipules or scales, which surround the young foot-

* "Papilla humorem excernens.'

† "Fulcrum secernens humorem."

‡ See the figures of Cassia marilandica, and Passiflora incarnata.

§ Bauhinia aculeata.

stalks of the flower and the leaves. Such glands are called by L., *glandulæ stipulares*, or stipular glands. In other plants, as in the Currant-tree, Fig-Wort, Viscous Campion, &c. &c. the glands are slender, like hairs: hence they are called *glandulæ capillares*, or capillary glands. A glandular appearance is frequently observed between the stamens of certain plants, particularly those which belong to the fifteenth class, Tetradynamia, of the Sexual System.* Although L. has been pleased to denominate the parts of which I have been speaking, glands, it is by no means certain, that they do, in reality, perform a glandular office. On the contrary, there are good reasons for suspecting, that many of the glandulæ, in the Linnæan sense of the word, are no ways concerned in the function of secretion.

These parts, whatever may be their uses, are of great importance in discriminating the species of certain genera of plants. Thus, the Almond and the Peach are two distinct species of one genus, the Amygadalus; but it is hardly possible to distinguish the two species, without calling in the aid of the glands. In the Almond, these are situated at the base of the leaves, upon the serratures; but the Peach is destitute of the glandular structure. To this general head of glands, L. seems to refer the following, viz. 1. *Folliculi*, follicles, or vessels distended with air, such as are observable at the roots of the Utricularia, or Water-Milfoil, and on the leaves of the Aldrovanda.† He might, with as much propriety, have added, the much larger bags, or vesicles, which are found upon various species of Fuci, or Sea-wreck. In these last, the air has been examined, and found to be much purer than atmospheric air. 2. *Utriculi*, or utricles, which are said to be filled with a secreted liquor; though, I believe, it cannot be proved, that it is, in *all* plants, a secreted liquor. The Nepenthes destillatoria, a native of Ceylon, furnishes us with a very remarkable example of what L. calls the utriculus. The extremity of the leaf of this plant terminates in a filiform process, and this, again, in a cylinder, which is closed at the end by an opercle, or lid, so as to retain water. Different species of the genus Sarracenia have hollow leaves, which retain, for a considerable time, the water that has been received into them, from the rain, dew, &c.‡ But I cannot think, that there is any manner of propriety in considering as glands, the curious structure of these two plants.

The last species of fulcre enumerated by L., is the Pilus, or Pubes. This is a general term, comprehending various species of pubescence, hairiness, or shagginess upon a plant; or, in other words, "whatever clothes it with any hairy or villous substance." The following species of pubescence are enumerated by the Swedish naturalist: viz. *Pili*, Hairs. 2. *Lana*, Wool; or close curled hairs. 3. *Barba*, Beard; or

* See Plate XIX. Fig. III.

† Aldrovanda vesiculosa, a native of the marshes, or standing waters, of India and of Italy.

‡ See Plate I.

parallel hairs. 4. *Tomentum*, Flocks; or interwoven villous hairs, scarcely conspicuous. 5. *Strigæ*, stiffish flattish hairs. 6. *Setæ*, Bristles; or stiffish roundish hairs. 7. *Hami*, Hooks; sharp crooked points. 8. *Glochides*, Barbs; straight toothed points, or pointed hairs.

Perhaps, there are very few plants entirely destitute of some kind of hairy covering, or pubescence. It is true, indeed, that to the naked eye, the leaves or other parts of many vegetables appear to be absolutely smooth: but, even in these, the microscope discovers various little hairs, or other species of pubescence. It is especially upon the young stalks or stems of plants, that this minute covering is discoverable. The hairs which are distributed over the surface of vegetables assume a considerable variety of forms. Thus, in the leguminous plants, they are generally cylindrical: in the malvaceous plants, they terminate in a point: in the Agrimonia, or Agrimony, they are shaped like a fish-hook: in Nettle, they are subulate, or awl-shaped, and jointed; and in some of the Syngenesious plants, that are furnished with hollow, or funnel-shaped florets, they terminate in two crooked joints. As early as the year 1682, the celebrated Dr. Nehemiah Grew, and in 1686 Marcellus Malpighi, had paid some attention to the different kinds of hairs which constitute a downy covering upon the surfaces of vegetables. But it was not until the year 1745, that the subject was handled in the masterly manner it deserved. In that year, Mr. J. Stephen Guettard, a very ingenious and learned French naturalist, began to publish his observations upon the hairs and glands of plants. These observations he continued during several succeeding years. The author has even established a botanical method, deduced from the form, the situation, and other circumstances of the hairy and other glandular appearances, on the surface of plants. He has shown, what perhaps would hardly have been suspected, that these appearances are, in general, constant and uniform in all the plants of the same family, or genus. Hence, he has observed, that they constitute good generic, but not specific characters. A minute investigation of the subject of vegetable pubescence would be more worthy of our attention, if we were acquainted with the actual use of this kind of covering. But upon this subject, little certain can be said. It seems very probable, that the pubescence of plants serves various useful purposes. I am inclined to think, that many of the hairs which cover the different parts of plants are exhaling and absorbing lymphatic vessels. Some seem to have been designed, in a great measure, for the purpose of preserving the parts where they are lodged, from the effects of friction; whilst others may form a kind of covering, like the furs, hairs, bristles, &c. of animals, for protection from cold, and other injurious causes.

L. asserts, that an experienced botanist will often find it easy to determine, from an inspection of plants, whether they belong to Africa, Asia, America, or the Alpine countries; though he may not be able to say, by what feature, in the general physiognomy, he has made the dis-

tinction. This naturalist, however, speaks of the American plants as being verdant, and smooth.* I do not doubt, that to the vegetables of extensive tracts of the three portions of the world which he has mentioned, a kind of national physiognomy often belongs: as we observe, that even the human inhabitants of such countries have a set of features exclusively belonging to them. Thus, an Anglo-American may, very generally, be distinguished from an Englishman. But I suspect, that there is much more difficulty than L. seems to have imagined, in deciding, with certainty, from the mere *facies*, or aspect, of vegetables, upon the native countries of those vegetables. How, indeed, can this be doubted, when it is considered, that the very same species of vegetables are common to two, and even three, quarters of the globe? Thus, the northern parts of North America, and the northern parts of Europe, possess a considerable number of vegetables in common with each other. Many species are common to Siberia, Kamschatka, Japan, &c., and to the north of America. A considerable number are common to the United States and to Hindostan; and even a few are common to the Cape of Good Hope and North America. That the American plants are *peculiarly* smooth, I am far from being convinced. L. might have found, in our woods, very many species covered over with all the various kinds of pubes, pubescentia, or pilus, which he has mentioned.† I cannot but suspect, misled by the phantom of a false analogy, he conceived the plants of America very smooth, partly, at least, because the man of America has been so generally deemed, and by L., among other writers, beardless, and smooth-skinned. But we now know, that the Indians of America are not more smooth than are the Japanese, the Chinese, the Koriaks, and many other nations or hordes of Asia.‡

IV. Hybernaculum, or Winter-Quarters of the Plant.

"Where dwell my vegetative realms benumb'd,
In Buds imprison'd, or in Bulbs intomb'd."

The Botanic Garden. Part I.
Canto I. l. 459, 460.

The hybernaculum, of Professor Martyn, is defined by L. to be a part of the plant which encloses the embryo-herb, protecting it from external injuries. In his langnage, it is either a *bulbus*, or a *gemma*.

I. Of the bulbus, or bulb, I have already made very particular mention. I have given my reasons for considering it as a species of root.

* Philosophia Botanica, &c. pp. 117. 118.

† Such, not to mention many others, are Rhus typhinum, Epigæa repens, Spiræa tomentosa, Sida Abutilon, many of the Oaks, Walnuts, or Hickories, and a very considerable number of species in the great class of Syngenesia.

‡ See New Views of the Origin of the Tribes and Nations of America. Preliminary Discourse, p. 55, and Appendix, p. 32.

At present, I am to take no farther notice of it, but to confine myself to the consideration of the Gemma, or bud. Previously, however, to my doing this, it will be proper to give some account of the *bulbus caulinus*, and other similar productions, to which I have alluded in a former part of the work. Consistently with my view of the subject, I could not, with propriety, treat of those productions, under the head of roots. The bulbus caulinus, or stem-bulb, is a small species of bulb, or hybernacle, which is situated immediately upon the stem or stalk of certain plants, having no immediate connection with the root. In the Dentaria,* or Tooth-wort, the Saxifraga, or Saxifrage,† the Lilium bulbiferum, or Bulbiferous Lily, and many other plants, we find small bulbs in the wings of the leaves, that is at the place where the leaf is united to the stem. If, after the stalks have decayed, these bulbs be taken off, and planted, they will soon take root, and vegetate. It is evident, therefore, that these productions are the repositories of an embryo or miniature-plant; and, therefore, they may, with strict propriety, be considered as a species of hybernacle. In some of the alliaceous plants, or plants of the Onion and Garlick kind, bulbs, very similar to those which I have just mentioned, are produced at the origin of the umbel of flowers, between the peduncles, or footstalks of the flowers. Such alliaceous plants are frequently called bulbiferous plants. The individual bulbs are well known among gardeners, and in common language, by the name of "cloves."‡ The structure of these cauline and umbel-bulbs appears to be very similar to that of the true root-bulbs, of which I have given an account. Bulbous granules, or productions, are very common in many species of Lichen, belonging to the twenty-fourth class of the Sexual System. But, in these Lichens, the bulbs are situated without the axils of the leaves.

In many plants, we observe an appearance, which, from its general affinity to that of the true bulbous granules, deserves to be mentioned in this place. Some species of Poa, and other grasses, shoot out from their flowers, bulbous-like processes, which falling to the ground, there take root, and vegetate into plants similar to the parent.§ Such plants are called vivaporous plants. In the Tangekolli, a plant of Senegal, which is particularly mentioned by Mr. Adanson, the seeds germinate in the fruit or capsule, forming bulbs, or suckers, even before the fruit has arrived at maturity. The Agave vivipara, of East Florida, exhibits a very similar appearance. After the flowers of this fine vegetable have fallen off, the seeds often vegetate, and even arrive to a pretty considerable size, their leaves being sometimes three or four inches long, whilst the new offspring is still attached to the parent tree. The branches of the Agave frequently appear alive with the young plants. These falling to the ground, there take root, and grow and flower. To this vegetable, a celebrated botanist, Paul Herman, gave the very appro-

* Dentaria bulbifera.

† Saxifraga bulbifera, and S. cernua.

‡ See Plate III.

§ Ibid.

priate name of *Sobolifera*.* The appearance exhibited by the Tange-kolli and Agave, may, not unaptly, be compared to that of a Polypus, with a numerous progeny sprouting from various parts of her body. Under this head of stem-bulbs, I may, with propriety, mention the fleshy and succulent leaves of various species of plants, particularly those of the lilliaceous order, such as the Aloe, the Squill, and others; and also the leaves of some species of Arum, or Cuckow-Pint. These, if they be carefully planted in the ground, will, in due time, emit radicles, or fibres, and vegetate. Hence, it is evident that there would be some propriety in denominating such leaves hybernacles. Perhaps, the leaves of all plants contain the miniature-embryons of millions of plants, which are never brought into open view. The bulbous granules, whether they be situated in the wings of the leaves, or other parts of the stalk, furnish the botanist with excellent marks for the discrimination of different species of plants, in the genera Ornithogalum, Dentaria, Polygonum, Saxifraga, Lilium, Allium, &c. Different species of these genera receive their specific names, *bulbifera*, or *bulbiferum*, and *vivipara*, or *biviparum*, from the bulbs which are found upon them.†

2. The hybernacle which more particularly claims our attention is the Gemma, or Bud. This is defined by L. to be a species of hybernacle sitting upon the ascending caudex, or stem, and branches, and composed of stipules, or petioles, or the rudiments of leaves, or cortical scales. In fact, every bud is to be considered as an epitome, or compendium, of one or more plants similar to the parent plant. In other words, the bud, as Lolling observes, is nothing else than the plant or vegetable straightened from a defect of the powers of vegetation.‡ The term hybernaculum, by which L. has designated the bulb and the bud, is very happily applied. Mr. Ray is said to have been the first person who gave to the bud, of which I am speaking, the name of *gemma*. Before his time, the bud had been denominated *germen*. It is admitted, indeed, that the term gemma was used before Ray's time, to signify a particular species of bud, viz. that which contains a flower; and some of the ancient authors appear to have carefully distinguished it from the germen, or bud, which contained leaves and wood. Pliny, whose merits are much greater than some writers will allow them to be, seems to mark the distinction between the gemma and the germen in very precise terms. The following are the words of the Roman naturalist: "Germen autem est id, quod ex ipsis surculis arborum primo vere exit, ex quo deinde folium producitur: nam gemma proprie est

* Aloe American Sobolifera.—Horti Academici Lugduno-Batavi Catalogus, &c. p. 16—18. pl. 2.

† Dentaria bulbifera, Saxifraga bulbifera, Dioscorea bulbifera, Lilium bulbiferum, Pelygonum vivaparum.

‡ "Gemma enim nihil aliud est, nisi herba coarctata a defectu vis vegetantis," &c.

floris, quanquam utrumque confundatur."* Notwithstanding the very precise observation of Pliny, I think there are good reasons for supposing, that some of the purest of the Roman classical writers, used the term gemma, to express every kind of bud, without any regard to its individual contents. Thus, when Virgil† speaks of the buds of the Vine, under the name of "gemmæ," he, doubtless, means the leaf and flower-buds of that vegetable:‡

With respect to the word Germen, although it appears that this term was also used to denote a bud, it would seem that it was more generally employed to denote a branch, or young twig, or sprout of a tree. Virgil,§ in describing the operation of vegetable inoculation, or budding, seems evidently to call by the name of "germen" the scion, or bud, which is made use of in this process:

Buds assume different forms in different vegetables. In general, however, they may be said to be small and rounded, or conical, bodies, sometimes ending in a point. But the form of the bud is often so different in the different species of the same genus, as to afford to the botanist a good mark of distinction, in the winter season, when the leaves and other parts, upon which the specific characters are more generally founded, cannot be seen. Thus, in many species of Willow, and in Rhamnus, or Buckthorn, the specific marks are often taken from the form of the buds. In general, buds are placed at the extremity of the young and tender vegetable shoots, and along the course of the branches. They are fixed, by a short footstalk, upon a species of brackets, which are the remainder of the leaves, in the axils of which the buds of the present were formed the preceding year. Sometimes, we observe only one bud in a place: sometimes two are together, and these are either opposite or alternate: whilst sometimes they are collected in greater numbers, in whirls, or rings. The construction of buds is at once beautiful and intricate. On the exterior surface of these vegetable cradles, we observe a number of scales, which are more or less hard, hollowed like a spoon, and laid over each other, in the manner of tiles upon the roof of a house. These scales are often beset with hairs, and other species of pubescence, and are fixed into the inner plates of the bark of the stem and branches, from which bark they seem to proceed. We cannot be at a loss to determine the use of these bud-scales. They serve to defend from cold, and other injuries, the tender and delicate embryon-plants, that are contained within the bud. The scales are often sealed, as it were, or connected to each other, and to the embryon within, by means of a thick, clammy juice, which in the buds of many vegetables, such as the Populus balsamifera, or Tacamahaca-tree, is of a resinous nature, and highly odoriferous. It is probable that, in some plants, this viscous matter may be useful by preventing an excess of perspiration

* Naturalis Historiæ. Lib.

† Ovid, too, as we shall afterwards see, calls the buds of the Vine, "gemmæ."

‡ Eclog. VII. l. 45—48. § Georgic. Lib. 11. l. 73—77.

from the bud. When the internal parts of the bud have expanded and unfolded, the scales, being no longer useful, fall off. The following observations of Ledermuller, an ingenious German naturalist, are well calculated to show the delicate and careful structure of the bud. In the winter season, he separated from a Horse-Chesnut (Æsculus Hippocastanum,) a bud not exceeding in size a common pea. He found the bud to be covered externally with seventeen scales, anointed with a viscid fluid. Having carefully separated these scales, the whole bud, covered with a lanugo, or down, was brought into view. On removing the down, he found the bud surrounded with four branch-leaves, and covering a spike of flowers. In this spike, our author very distinctly counted sixty-eight flowers! By the assistance of a microscope, even the pollen, or fecundating powder of the stamens, was observable. Some of it was opaque, and some transparent. Three different species of buds are enumerated by the botanists. These are 1. a bud containing a flower; 2. a bud containing a leaf or leaves; and 3. a bud containing both flowers and leaves.

I. The first species of bud that I have mentioned, is denominated *gemma florifera*, or the flower-bud. This contains the rudiments of one, or several, or many flowers, without leaves, folded over each other, and surrounded with scales. To this species of bud, the French have given the name of "bouton a fleur, ou au fruit." It is often found at the extremity of the small branches of certain trees, which branches are shorter, more rough, and less beset with leaves than the other branches. It is also observable, that this flower-bud is, in general, thicker, shorter, more square, and less pointed than the other kinds, which are next to be mentioned. It commonly terminates obtusely. This is the *gemma floralis* of L. This species is particularly mentioned by Pliny, who calls it *oculus gemma.* It is the bud which is employed in that species of grafting, which is called inoculation, or budding.

2. The second species of bud is the *gemma foliifera*, or leaf-bud. It contains the rudiments of several leaves, without flowers. This kind of bud is commonly more pointed than the first species. In some vegetables, however, as the Hazle-nut, it is nearly round; and in the Æsculus Hippocastanum, or Horse-Chesnut, it is very thick. L. calls this species of bud, *gemma foliaris.*

3. The third species of the bud is the *gemma foliifero-florifera*, or flower and leaf bud. This is the most common species of bud. In general, it is smaller than either of the two preceding buds, and produces, as the name imports, both flowers and leaves. L. denominates this bud, *gemma communis.* In this species, however, the flowers, which are mixed with the leaves, are not always of the same kind. Sometimes, the bud protrudes, 1. male-flowers with leaves, as in the Pine, and Fir-tree. 2. female-flowers and leaves, as in the Hazle-nut, and Carpinus, or Horn-beam. 3. hermaphrodite flowers, and leaves, as in the Elm-tree, Cornus, or Cornel-tree, Daphne, or Mezereon, and the Almond-tree. Those buds which are evolved into leaves only, are called

barren-buds. Those, which contain both leaves and flowers, are denominated fertile. These terms are very properly applied. It is observed, that from the size or bulk of the bud, we can often foretel, whether it contains merely leaves, or flowers and leaves together.

The final object or ultimate end of the Great Creator of the Universe, in forming buds, must now be sufficiently obvious. They are the protecting domes, the cradles, of tender embryons, which, in due time, are to burst from their enclosures, expose themselves to the light of the day, and spread eternal beauties over this earth.

The greater number of the trees and shrubs of cold climates are furnished with buds. In such climates, the protection which buds afford is wanted. Lofling has observed, that the Frangula, a species of Rhamnus, or Buckthorn, is the only native tree of Sweden which is destitute of buds.* And how beautifully does this vegetable demonstrate the office of the bud! The Frangula requires not the protecting aid of these winter quarters: for "it grows under the trees, in the marshy forests, where it is defended, along with other plants, from the severity of the winter."† Buds are seldom found upon the vegetables of warm climates. In climates which enjoy an uniform series of mild or warm seasons, the tender shoots of vegetables do not stand in need of the protection of buds. The following list, from Lofling, will show what vegetables, among others, are destitute of buds: viz. Citron, Orange, Lemon, Cassava, Mock-Orange, Blad-Apple, Shrubby Swallow-wort, the Shrubby Geraniums,‡ Berry-bearing-Alder, Christ's Thorn, Syrian Mallow, Adansonia or Baobab, Justicia, Wild Senna, the Acacias and Mimosas, Coral-tree, Stinking Bean Trefoil, Oleander, Tamarisk, Heath, Barbadoes-Cherry, Tree-Mallow, the Shrubby Nightshades,§ Guinea Henweed, Cypress, Lignum Vitæ, and Savin. Some of the vegetables, in this list, are large trees, such are the Adansonia, several of the Mimosas, &c. whilst others are smaller, but furnished with ligneous or woody stems, and belong to the families of shrubs and under-shrubs, as they are denominated by the English writers.

True or complete buds are never produced upon the annual plants, or those whose whose root and stem perish after the term of a year. In these, however, small branches, like minute feathers, are protruded from the axils of the leaves. These feather-like processes, which seem

* See his excellent paper, entitled "Gemmæ arborum," in the Amoenitates Academicæ. Vol. II. Dissertatio XXIV.

† "Frangula est unica arbor indigena *Sueciæ*, quæ gemmis caret, sed habitat illa sub arboribus, in nemoribus paludosis, cum aliis plantis a sevitia hyemis defensa."

‡ Geranium fulgidum, G. inquinans, G. papilionaceum, G. betulinum, G. scabrum, G. cucullatum, G. gibbosum, G. carnosum, G. peltatum, G. acetosum, G. zonale, G. vitifolium, &c. &c. of L.

§ Solanum verbascifolium, S. guineense, S. Pseudo-Capsicum, S. diphyllum, S. bonariense, S. pimpinellifolium, S. sanctum, S. tomentosum, S. bahamense, &c. of L.

to supply the place of the buds, wither without undergoing a more complete evolution or expansion, if the plants to which they belong are scandent, that is climb, and are destitute of lateral branches. But, in many other annual plants, these feather-like bodies, or small branches, grow into plants, similar to the parents. In the trees of warm and hot countries, an appearance similar to that which I have described, is observed to obtain. In these trees, several of which are enumerated in the preceding list of budless vegetables, a plumula, or small feather, emits branches, without, however, any scaly covering: for, as I have already observed, this covering is not wanted where there is no severity of climate to injure the tender shoot. The scaly covering essentially belongs to completely formed buds. "When we, therefore, speak of trees having buds, that are naked or without scales, our meaning is the same as if we had said, that they have no buds at all."*

Mr. Ray and Pontedera, have instituted a division of vegetables into herbs, or herbaceous vegetables, and trees, founding the distinction upon the absence or the presence of the gemmæ, or buds. The herbs they have distinguished by the name of plants wanting buds: the trees by that of vegetables bearing buds. This division is certainly erroneous, and is calculated to introduce much confusion into the science of vegetables. It might not be improper, indeed, to adopt such a distinction in the history of the plants of one country, not very extensive, or not enjoying very different climates. But it ought not to be adopted in the history of the plants of the whole globe; since it plainly appears, that the greater number of the trees of warm climates are destitute of buds, or at least of that scaly appearance, which seems to belong essentially to buds; and, hence, such trees, some of which are very large and stately, ought, upon the principles of the two authors whom I have mentioned, to be thrown into the same class or series as the humble, herbaceous plants. Father Plumier discovered much judgment in associating together the trees and the herbaceous plants; though his illustrious countryman, Tournefort, had kept them asunder.

With respect to the origin of buds, two different opinions have been entertained by botanists. Pontedera imagined that the buds derive their origin from the ligneous, or woody fibrillae. This opinion has not, so far as I know, been adopted by any succeeding naturalist.

It is much more probable, that the buds derive their origin from the medulla, or pith of the vegetable. It is certain, that the pith is essentially necessary to the existence and growth of the buds. But this subject will come more naturally to be treated of, when examining the anatomical structure of vegetables. As every vegetable bud contains the *primordium*, or embryon of a plant, and if separated from its parent, and nurtured with care, would produce a plant specifically the same as the supporting stock, we are led to reflect upon the unbounded fertility of Nature, who seems to have taken delight in forming (I would

* Milne.

say to the extent of her power, if to the power of Nature there were any limits,) living, organized existences. L. has made a calculation, by which it appears, that ten thousand buds, or, in other words, ten thousand herbs, may be produced from a single trunk, not exceeding a span in diameter. What an infinity of plants, then, might be raised from some of the most stupendous trees, such as the Adansonia of Africa, or the Liriodendron, Platanus, and others of North America. But the fertility of Nature, in the formation of buds, is infinitely greater than even philosophers themselves have, in general, imagined. Millions of buds lie latent in the tree, and never meet the light of the day. The embryon punctum is not evolved into notice, from a deficiency of those stimulating agents, which, if they be not the sole cause of life, are, at least, essentially necessary to bring the phenomenon of life into view.

SECTION III.—OF THE FRUCTIFICATION.

The fructificatio,* or fructification, is beautifully defined by L. to be a "temporary part of vegetables, dedicated to the business of generation, terminating the existence of the old, and beginning the era of the new, vegetable."† The essence of the fructification consists in the flower and the fruit. These two parts are connected in the same manner as generation and birth are connected together in animals. For although the fruit does not swell and come to perfection, until after the flower has decayed, or fallen, it seems to be sufficiently established as a fact, by the experiments of many learned men, that the *primordia*, or earliest rudiments, of the fruit, pre-exist in the flower. When perfect, the fructification consists of the following seven parts, viz. 1. the *Calyx*. 2. the *Corolla*. 3. the *Stamen*. 4. the *Pistillum*. 5. the *Pericarpium*. 6. the *Semen*. 7. the *Receptaculum*. Of these, the four first belong to the flower, properly so called; the two next to the fruit, and the last is common to both.

I. The Calyx,‡ is defined by L. the "outer bark of the plant, present in the fructification." It is frequently denominated, by English writers, the empalement and flower-cup. It seems more proper, however, to adopt the Latin word; since the word flower-cup, if used, ought certainly to be restricted entirely to one particular species of calyx, the perianthium, or perianth; whereas the term calyx is a generic term, comprehending, as we shall presently see, various parts, very distinct in their appearances, and perhaps, in their office. L. enumerates seven

Fructificatio, from Fructus, fruit, and facio, to make.

† "Fructificatio Vegetabilium pars temporaria, Generationi dicata, antiquum terminans, novum incipiens." Philosophia Botanica, &c. p. 52.

‡ Calyx, from καλυξ, and originally from καλυπτω, to cover: not, as some writers have supposed, from καλιξ, a cup.

different kinds of calyx: viz. the *Perianthium*. 2. the *Involucrum*. 3. the *Amentum*. 4. the *Spatha*, 5. the *Gluma*. 6. the *Calyptra:* and 7. the *Volva*.

1. The Perianthium,* or Perianth, is the most common species of calyx. It is placed most contiguous to the fructification; or, in other words, immediately under the flower, which, in many plants, is contained in the perianth, as in a cup. On this account, this species of calyx has been denominated the flower-cup. It is also called the Empalement.

Various species of perianthium are enumerated by L. A. The *Perianthium fructificationis*, or perianth of the fructification, includes both the stamens and the germ: that is, the male and female organs of generation. This is the most common species of perianth. It is exemplified in Nicotiana, and various other plants. B. The *Perianthium floris*, or perianth of the flower, contains the stamens, but not the germ. This species of perianth is exemplified in the Epilobium, Gaura,† and all those other vegetables which have the germ or seed-bud placed below the receptacle of the flower. C. The *Perianthium fructus*, or perianth of the fruit, contains the germ, but not the stamens. This is exemplified in the females of many of the plants of the two classes Monoecia and Dioecia.‡ Linnæa, Clove-tree, Morina, and several other vegetables, have two perianths, which very well illustrate the two last mentioned terms. In these vegetables, one of the perianths is appropriated to the flower, whilst the other belongs to the fruit.

a. With respect to the number of the leaves, of which it is composed, the perianth has received the following names: viz. 1. *perianthium monophyllum;* a one-leafed perianth, composed of only one leaf; as in Tobacco, Thorn-Apple, Primrose, and many other plants. 2. *Perianthium diphyllum*, a two-leaved perianth, consisting of two leaves; as in the Poppy, Claytonia, Fumatory. 3. *perianthium triphyllum*, a three-leaved perianth; consisting of three leaves, as in Dock, Magnolia, Tulip-tree, Annona, or Papaw, Podophyllum peltatum, or May-apple, &c. 4. *perianthium tetraphyllum*, a four-leaved perianth, consisting of four leaves: as in Water-Lily, Heath, the plants of the class Tetradynamia. 5. *perianthium pentaphyllum*, a five-leaved perianth, consisting of five leaves; as in Ranunculus, Glass-wort, Beet, Flax, and a great number of those plants, the flowers of which have more than one petal. 6. *perianthium hexaphyllum*, a six-leaved perianth, consisting of six leaves; as in Lions-leaf, Berberry, Hillia parasitica, &c. 7. *perianthium heptaphyllum*, a seven-leaved perianth; consisting of seven leaves; as in Trientalis, or Winter-green. 8. *perianthium octophyllum*, an eight-leaved perianth, consisting of eight leaves, as in Mimusops, and Diapensia. 9. *perianthium decaphyllum*, a ten-leaved perianth; consisting of ten leaves; as in Galax. 10. *perianthium po-*

* Perianhium, from περι, around; and, ανθος, a flower.

† See Plate XVI. Fig. 2. ‡ See Plate XXIX. fig. 2.

lyphyllum, a many leaved perianth; consisting of many leaves, or more than ten.

b. A one-leaved perianth is either, 1. *integrum*, entire; that is undivided, as in Genipa and Olax. 2. *bifidum*, two-cleft; cut into two segments or divisions, as in Tuberous Moschatel, Purslane, &c. 3. *trifidum*, three-cleft; cut into three segments, or divisions; as in Hermannia and Cliffortia. 4. *tetrafidum*, four-cleft; cut into four segments or divisions; as in Galium, and Elephant's head. 5. *quinquefidum*, quinquefid, or five-cleft; as in Tobacco, and the greater number of flowers that are furnished with a calyx of one leaf. 6. *sexfidum*, six-cleft, or cut into six segments; as in Ginora americana. 7. *octofidum*, eight-cleft; as in Tormentil. 8. *decemfidum*, ten-cleft, as in Cinquefoil, and Herb-Bennet: and 9. *duodecemfidum*, twelve-cleft; as in Purple Loosestrife, and Water-Purslane.

c. In respect to figure, a perianth is either, 1. *tubulosum*, tubular; or running in the form of a tube. 2. *patens*, spreading. 3. *reflexum*, reflex, or bent back; as in Asclepias, and Leontodon. 4. *inflatum*, inflated, hollow, or puffed up like a bladder; as in Physalis, called Ground-Cherry. 5. *globosum*, globose, or globular. 6. *clavatum*, club-shaped; as in Silene. 7. *erectum*, erect or upright.

d. In regard to the proportion which it bears to the corolla, the perianth is, 1. *abbreviatum*, abbreviated, or shorter than the tube of the corolla; as in Tobacco,* and most other plants. 2. *longum*, long; longer than the tube of the corolla. 3. *mediocre*, middle-sized; about the length of the tube of the corolla.

e. At its top, the perianth is, 1. *obtusum*, obtuse. 2. *acutum*, acute. 3. *spinosum;* spinous or thorny. 4. *aculeatum*, prickly. 5. *acuminatum*, acuminate.

f. The perianth is, 1. *æquale*, equal, having all the segments of the same size. 2. *inæquale*, unequal; when some of the segments are smaller than others. 3. *labiatum*, lipped; when the segments are irregular, and formed into two lips.

g. The perianth, with respect to its margin, is, 1. *integerrimum*, very entire. 2. *serratum*, serrated. 3. *ciliatum*, ciliate.

h. The perianth has received a variety of names, according to its surface. But these names have already been explained, in treating of the terminology of leaves.

i. The situation of the perianth, with respect to the germen, is, 1. *superum*, superior; when the germen is under the lower part of the perianth. 2. *inferum*, inferior, when the germ is above the base of the perianth.

k. In respect to its duration, the perianth is either, 1. *caducum*, caducous, or falling off before the complete opening of the flower; as in the Poppy and the Barrenwort. 2. *deciduum*, deciduous, or falling off with the flower, that is the petals, the stamens, and the style; as in Ber-

* See Plate XI. fig. 1.

berry and the Cross-shaped flowers. 3. *persistens*, permanent; or continuing until the fruit has attained to maturity; as in the lip and masqued flowers, and several others.

l. 1. In respect to its composition, the calyx sometimes consists of a number of leaves, which are laid over each other, like tiles, or scales. This is the *perianthium imbricatum*, or imbricate calyx. Hawk-weed, Sow-Thistle, and many other Syngenesious plants, furnish us with beautiful instances of this species of calyx.* Sometimes the scales of the calyx spread wide, and are diffused on all sides, and not closely laid over each other, as in the preceding species. This last is the *perianthium squarrosum*, or squarrose calyx; of which we have examples in Thistle, Onopordum, Conyza, &c.† 3. In some plants, as in the Pink, Coreopsis, and others, the base of the calyx, which is simple, is surrounded, externally, by a series of distinct leaves, which are shorter than its own. To this species of Calyx, L. has given the name of *calyx auctus*, and Vaillant, *calyx calyculatus*, an increased calyx, caliculate, or calycled calyx. 4. The *perianthium scariosum*, or scariose perianth, is a species of calyx, which is tough, thin, and semi-transparent; as in Statice Armeria, or Thrift, Centaurea, glastifolia, &c. 5. The *perianthium turbinatum*, turbinate, or top-shaped perianth, is inversely conical, and shaped like a boy's top, or a pear. The Grislea secunda and Memeclyon capitellatum exhibit instances of this species of perianth.

m. The perianthium is either, 1. *proprium*, proper, that is belonging to one flower; or, 2. *commune*, common, belonging to several flowers, collected together.

n. Some flowers, such as the Amaryllis, the Tulip, the Lily,‡ and many others of the liliaceous plants; also the Medeola,§ are said to be destitute of the perianth. But I shall afterwards have occasion to observe, that what the Swedish naturalist names, in these flowers, the corolla is deemed the calyx, by some other eminent botanists.

In the greater number of plants, the perianth is single. In Morina, Sarracenia,‖ and some of the plants of the Mallow-family, as Althæa, Alcea, Malva, Lavatera, Gossypium, Hibiscus, &c. it is double.

2. The second species of calyx, which I have mentioned, is the *Involucrum*.¶ This is called by Dr. Martin, Involucre. It is chiefly restricted by L. to the umbelliferous flowers, and is defined, by this writer, a calyx remote from the flower.** This species is placed below the common receptacle, which, in the umbelliferous plants, is a number of footstalks, which all proceed from one common point or centre, and rise to the same height. Each of the footstalks is terminated by an

* See the Plate of Silphium terebinthinaceum.

† See the Plate of Helianthus divaricatus.

‡ See Plate XIII. fig. 2.

§ See Plate XIV.

‖ See Plate I.

¶ *Involucrum*, from *involvo*, to wrap up.

** "Calyx umbellæ a flore remotus."

umbel, which is similar, in its form and structure, to the large umbel, and is commonly, like it, furnished with an involucre. When a calyx of this kind is placed under the universal umbel, it is called, by L. *involucrum universale*, an universal involucre. When it is placed under the smaller or partial umbel, it is denominated *involucrum partiale*, a partial involucre. This is sometimes termed, *involucellum*, or involucret. Dr. Withering calls it the Partial Fence. In most of the umbelliferous flowers, such as the Hemlock, Fennel, Anise, and in other plants, not strictly umbelliferous, as the Cornus florida, or Dogwood, and other species of this genus, there is, besides the two involucres, a proper perianth, which is situated under each of the florets, or smaller flowers, of which the umbel is composed. The involucre is composed of one or more leaves. When composed of one, it is denominated *involucrum monophyllum*, a one-leafed involucre, as in Bupleurum: when of two leaves, *involucrum diphyllum*, a two-leafed involucre, as in Euphorbia: when of three, *involucrum triphyllum*, as in Butomus and Alisma: when of four, *involucrum tetraphyllum;* as in Cornus: when of five, *involucrum pentaphyllum*; as in Daucus; and when of six, *involucrum hexaphyllum*; as in Hæmanthus. The partial involucre, or involucret, consists either of two leaves, as in Artedia; of five, as in Hare's ear; or of many, as in Bishop's-weed, and Fennel-Giant. The *involucrum dimidiatum*, dimidiate, or half-leaved involucre, is an involucre which is deficient on one side; as in Æthusa, or Fool's Parsley. It is difficult to say, in what very essential circumstance the involucre of those plants which are not umbelliferous, such as Cornus, or Dogwood, some species of Anemone, &c. differs from the bractea, or bracte. It would seem, indeed, that L.'s principal reason for separating the involucre from the bracte was this, that he might make use of the former part in drawing his generic characters of the umbelliferæ.

3. The amentum,* or Ament, called also Catkin, is a species of calyx, which consists of a great number of chaffy scales, that are dispersed along a slender thread, or receptacle. On account of its supposed resemblance to a cat's tail (though it bears as close a resemblance to the tails of many other animals as to that of the cat,) it has received one of its English names, viz. catkin. The French call it Chaton; and many botanists have denominated it Catulus. The term amentum was used by the great Tournefort, before it was employed by L. The term is perfectly synonymous as the terms julus and nucamentum, which are employed by some botanists. L. defines the ament to be a composition of a calyx, and a common receptacle. The squamæ, or scales, which form this species of calyx, are mixed alternately with the flowers, and resemble the chaff in an ear of corn.† The ament occurs very frequent-

* The term amentum, as used by the Roman writers, signifies a thong, a loop, a strap, or lash, to hold a sling, spear, or javelin by.

† For a fine representation of the ament, see the figure of Betula populifolia, in this work.

ly in the twenty-first and twenty-second classes of the Sexual System, the classes Monoecia and Dioecia, the particular characters of which are afterwards to be explained. In this place, however, it is proper to observe, that in the first mentioned class, the ament supports both male and female flowers, on the same root, or individual. This is the case in the Hornbeam, Walnuts, and Hickories, Chesnut, Chinquepin, and many others. In the class Dioecia, the ament supports male and female flowers, on distinct roots, or individuals. This is the case in the Willows, Poplars, and many others. It not unfrequently happens, that in plants of the class Monoecia, the male and female flowers are mixed together, or situated very close to each other; whilst in other plants, they are situated at a considerable distance from each other; but, in both instances, upon the same root, or individual. In the latter case, the ament frequently supports flowers of one sex, and a calyx of the perianth kind supports those of another sex. Thus, in the Corylus, or Hazle, the male and female flowers are placed remote from each other, upon the same root or individual. The male flowers form an ament, whilst the females are inclosed in a perianth. In the class Dioecia, there are some plants, such as Pistachia-nut, Juniper-tree, and Ephedra, or Shrubby Horse-tail; the male flowers of which are formed into an ament; whilst the female flowers are surrounded with a perianth. In general those flowers, whether they be male or female, or both, which are supported by an ament, are destitute of the petals, or painted leaves. The Oak, the Beech, the Hazel, the Cypress, the Pistachia-nut, and several others, are illustrative of this observation.

4. The Spatha,* or Spathe, is a particular species of calyx, which opens, or bursts longitudinally, in form of a sheath, and produces a stem, which supports one or more flowers. It consists either of one piece, as in the Narcissus, Snow-Drop, and the greater number of plants that are furnished with this species of calyx. 2. of two pieces, as in the Stratiotes, or Water-soldier; or 3. of a number of scales, which are laid over each other like tiles; as in Musa, or Plantain-tree. The first species of spathe is called by L. *spatha univalvis*, a one valved spatha; the second, *spatha bivalvis*, a two valved spathe; and the last, *spatha imbricata*, an imbricate spathe. The *spatha dimidiata*, or halved spathe, is a spathe which invests the fructification only on the inner side. According to the number of flowers which it produces, the spathe has received different names, such as 1. *spatha uniflora*, a one-flowered spathe. 2. *spatha biflora*, a two-flowered spathe. 3. *spatha multiflora*, a many-flowered spathe. L., in his *Fragments of a Natural Method*, has established an order of plants, to which he has given the name of *Spathaceæ*. This order embraces a number of very fine vegetables, some of which have already been mentioned, in a former part of this work.

* Spatha, in the Latin language, has various significations, such as a two-handed, or bastard-sword, a spatula, the branch of a Palm-tree, &c. &c.

I shall here give the list of all the genera that were known to L. They are all furnished with that particular species of calyx which I have been considering. Allium, Amaryllis, Bulbocodium, Colchicum, Crinum, Galanthus, Gethyllis, Hæmanthus, Leucojum, Tulbagia, Narcissus, Pancratium. The Massonia of Thunberg, the Cyrtanthus of the younger L., and the Agapanthus of L'Heritier, also belong to this order.

5. The Gluma,* or Glume, is a species of calyx restricted to the gramina, or grasses. It is formed of valves, and embraces the seed. This species of calyx, which is also called the Husk or Chaff, is frequently terminated by a stiff pointed prickle, called the awn, or beard. *a.* The glume has received different names, according to the number of flowers which it supports: such as, 1. *gluma uniflora*, a one-flowered glume. 2. *gluma biflora*, a two-flowered glume. 3. *gluma triflora*, a three-flowered glume. 4. *gluma multiflora*, a many-flowered glume.

b. Various appellations have also been given to the glume, according to the number of its valves: viz. 1. *gluma univalvis*, an univalvular, or one-valved glume. 2. *gluma bivalvis*, or bivalvular glume, consisting of two scales. This is the most common species of glume. 3. *gluma multivalvis*, a multivalve, or many-valved glume; having more than two scales, or valves. *c.* The glume is, 1. *colorata*, coloured; of any colour but green, which is the general colour of this species of calyx. 2. *glabra*, smooth. 3. *hispida*, hispid; shaggy or rough with hairs. *d.* The glume is either, 1. *aristata*, awned; having an awn. 2. *mutica*, awnless; blunt, or without any point at the end.

The *Arista*, or awn, is a slender and sharp process, which issues from the glume of many grasses. In English, this part is commonly called the Beard. But this latter term ought not to be applied to the awn, since it is systematically appropriated to a particular species of pubescence. To the awn, as well as to the glume itself, various names have been applied, such as the following: viz. 1. *terminalis*, terminating, fixed to the top of the glume. 2. *dorsalis*, dorsal; placed on the back, or outside of the glume. 3. *recta*, straight; issuing from the glume in a perpendicular direction. 4. *tortilis*, twisted, or coiled like a rope. 5. *recurvata*, recurved, or bent back; and, 6. *geniculata*, geniculate; or bent like the knee-joint.

Plants that are furnished with the species of stem which we have called the culm, and with the glume, in place of a calyx, are known among botanists by the name of *Plantæ Culmiferæ*, or Culmiferous plants. By L. they are denominated *Gramina*, or grasses. Wachendorf† calls them *Glumosæ*. The greater number of these grasses are furnished with hermaphrodite flowers, and belong to the third class of the Sexual System. Some important species belong to the other classes, particularly to the sixth class, where we find the Oryza, or Rice; and to

* Gluma, from *glubo*, to bark, or take the bark from a tree.

† Horti Ultrajectani Index. 1747.

the twenty-first class, to which belongs the Zea Mays, or Indian corn, &c. Some species belong to the twenty-third class. Haller and Scheuchzer affirm, that in *many* of the grasses, they have found but two stamens. This is denied by L. But the authority of Haller ought not to be questioned. L. perhaps without the best foundation, considered the grasses as the most simple of all plants, in regard to their structure. He has also observed, that very few of these vegetables have any taste; that many of them are insipid, like the Olera, or pot-herbs; that a very small proportion are fragrant, and that none of them are poisonous.* Many of the grasses, however, have a very agreeable, sweetish taste; some of them possess an astringent quality; and in this very interesting class, there are some very fragrant plants. such, not to mention others, as the Seneca-grass of the United States. This has a most agreeable smell, very similar to that of the pod of the Vanilla. It is much esteemed by the Senecas, and other Indian tribes. From the Senecas, it receives its name.

That none of the grasses are poisonous, is not consonant to the observations of other botanists. The Lolium temulentum, or Darnel, is commonly esteemed a noxious species of grass, and without doubt it is so. This is the plant which Virgil calls infelix, or unhappy.†

Actual experiments, however, seem to show, that it is much less poisonous than has been generally imagined. Manetti‡ observes, that this grain may be eaten with impunity, provided there be mixed with its meal a larger proportion of the meal of other *cerealia*, or grains; and the compound mass be subjected to a second, but gentler, baking; care, at the same time, being taken, not to eat the bread too warm. He applies the same observations to the Bromus secalinus, or Field-Brome grass. The grasses constitute one of the most natural families of plants with which we are acquainted. It will be a happy era in Botany (the era is unquestionably remote,) when the labours of learned men shall have disposed of all, or the greater number of plants, into classes or orders, as unexceptionable, and as agreeable to the Scheme of Nature, as is the order of *Gramina*.

6. The Calyptra,§ or Calyptre, is said to be the calyx of the mosses, covering the anther, or male organ, of this family of vegetables, like a hood, monk's cowl, or extinguisher. But, the Calyptre cannot, I think, be considered as a real calyx. It is, moreover, to be observed, that the part, which L. calls the anther of the mosses, is known to be the capsule, or pericarp, of these vegetables. It is either, 1. *recta*, straight; equal on every side; or, 2. *obliqua*, oblique, bent on one side.‖

7. The Volva, or Ruffle,¶ as Dr. Withering calls it, is defined to be

* Prælectiones in Ordines Naturales Plantarum, p. 137.

† Georgic. Lib. I. l. 147—154.

‡ Delle specie diverse di frumento e di pane, &c. &c. Firenze: 1765.

§ Calyptra, from καλυπτω, to cover.

‖ See Plate XXX.

¶ See Plate XXX.

the membranaceous calyx of a fungus plant. It is also called the Curtain. This ought not to be considered as a species of calyx, and is, to all appearance, a part of very little consequence in the vegetable economy. The volva is said to be, 1. *approximata*, approximating; when it is placed upon the stem of the fungus, near the cap. 2. *remota*, remote; when it is at a distance from the cap. In order to convey to the reader some idea of the relative proportion that obtains, in respect of number, between the several species of calyx which I have enumerated, it will not be amiss to notice the following observations, by Dr. Alston, of Edinburgh. In the year 1753, that learned, but acrimonious opposer of the Sexual System of L., published his *Tyrocinium Botanicum*. At this period, the *Genera Plantarum* of L. contained only 1021 genera, or families of plants. Of these, according to the professor, 673 have for their calyx a perianth: 72, a spathe: 75, an involucre: 29, a glume: 18, an ament: and 3, a calyptre. Of the volva, or ruffle, Alston has taken no notice; nor ought he to be blamed for the omission: for this imaginary calyx is never once named by L., in drawing the characters of the genera of Fungous plants, which were at that time enumerated in the *Genera Plantarum*. Dr. Alston also remarked, that about 110 genera were entirely destitute of the calyx; that 25 have both a perianth and an involucre; and a few both a perianth and a spathe. Since the time of Alston, the accessions to Botany have been immense. But I have not leisure to pursue the subject of the relative proportion of the different species of calyx, in the many thousand species of plants that are now known. I shall only observe, in this place, that within the last twenty or thirty years, Botany has been enriched with a very great proportion of plants, that are furnished with two of the species of calyx; I mean the glume and the calyptre. In his attempt to establish the analogy between the animal and the vegetable kingdoms, L. has designated the calyx by the name of *thalamus floris*, or the conjugal bed.* But this poetical language seems but ill adapted to the grave dignity of science. I may add, that the Swedish naturalist would have used a less exceptionable phrase, had he considered the perianth merely as the conjugal bed. With no manner of propriety can this term be extended to the spatha, the volva, and calyptre. Dr. Grew has observed, that the design of the empalement, or perianth, is to enclose, secure, and support the other parts of the flower; to be their security before its opening, by intercepting all extremities of weather; and afterwards to be their support, by containing all the parts in their due, and most graceful posture. Hence, continues this celebrated vegetable physiologist, we have the reason why the calyx is frequently various, and sometimes wanting. Some flowers have none, as Tulips; because having a fat and firm leaf, or petal, and each leaf likewise standing upon a broad and strong basis, they are thus sufficient to themselves. Carnations, on the

* "Calyx ergo est *Thalamus*, Corolla *Auleum*," &c. Philosophia Botanica, &c. p. 92.

contrary, have not only an empalement, but that, for greater support, of one leaf: for, otherwise, the foot of each leaf or petal, being very long and slender, most of them would be apt to break out of compass. In the same flower, the top of the empalement is indented, that the indentments may protect the petals; by being lapped over them before their expansion, and afterwards may support and prop them up, by being spread under them.* There can, perhaps, be little doubt that the calyx, or more specifically speaking, the perianth, is of essential use, as Dr. Grew asserts, in giving security or protection to the petals, and other parts of the flower. In many plants, the calyx likewise serves the office of a pericarp or seed-vessel; as in the plants of the order Gymnospermia, in the class Didynamia. But these, I am inclined to think, cannot be the only uses of the perianth. It is probable, that this part is concerned in the great business of a vegetable respiration. This opinion, which has been suggested by some ingenious writers, will appear more probable from the view which will afterwards be given of the uses of the corolla, and the near relations of this part of the fructification to the perianth. With respect to the involucrum, I have already hinted at the affinity which this species of calyx bears to the bracte. There seems to be as good reason to consider the involucre of many plants a pulmonary system, as to consider the bracte in this light. Of L.'s opinions concerning the origin of the calyx, viz. that it is a continuation of the cortex, or outer bark of the vegetable, I shall take more particular notice afterwards.

II. The Corolla,† which some English writers have denominated the Corol, is the second of the seven parts of fructification already enumerated. L. defines it "the liber or inner bark of the plant present in the fructification.‡ Some writers have translated the term corolla by Blossom. But Dr. Martyn has observed, that "blossom has a more contracted signification in English, being usually applied to the flowers of fruit-trees." The petals of the corolla are frequently called, both in common language, and in the writings of poets and philosophers, "the leaves of the flower."

I shall retain, without any alteration, the Latin word Corolla, which ought, I think, to be preferred to Dr. Darwin's word Corol. The segments of the Corolla I shall call Petals. The corolla, according to L. consists of two parts, viz. the *Petallum*, or Petal, and the *Nectarium*, or Nectary. The last, however, is not always a part of the corolla. It it is said that, in general, the corolla may be distinguished from the perianth by the fineness of its texture, and the gayness of its colours; the perianth, or calyx, being usually rougher, and thicker, and of a green colour. But to this rule there are many exceptions. Thus, in Bart-

* Grew, as quoted by Milne.

† Corolla, in the Latin, literally signifies a little crown, or garland; a chaplet, a coronet.

‡ Liber plantæ in Flore præsens." Philosophia Botanica, &c. p. 52.

sia,* the perianth is coloured, even more so than the corolla. The perianth of Fuschia coccinea is a bright scarlet: the corolla, indigo coloured. The perianth of Dombeya lappacea,† before the opening of the flower, is of a crimson colour. It afterwards becomes green. The corolla is of a brownish-violet colour. Moreover, the corolla of Daphne Laureola is green. The calyx is painted. The perianth and the corolla of Bignonia radicans (Trumpet-flower,) are both of the same colour. It is necessary, then, to have recourse to other marks, by which these two parts of the fructification may be accurately discriminated from each other.

L. makes the distinction between the corolla and the perianth to consist in this circumstance, that the former has its segments, or petals, disposed alternately with the stamens; whereas the perianth has its parts, or leaflets, arranged opposite to the stamens. "This rule," says Dr. Milne, "determines with precision, in such flowers as want either the calyx or petals. Thus, in Pellitory, Wild Orach, and Nettle, one of the two covers is wanting. Which is it? Am I to infer that the single cover present is the corolla, because the finer and more principal part. Nothing would be more erroneous than such an inference; many flowers, as Water-Purslane, Ruellia, and Bell-flower, which generally have both covers, are found occasionally to lose the petals, but never the calyx. How then am I to proceed? Apply the rule mentioned above. I do so, and finding the divisions of the only cover that is present, to stand opposite to the stamina, I conclude that cover to be the calyx. That the rule just mentioned, is founded in the natural situation of the parts in question, will appear, by examining any number of complete flowers in the fourth and fifth classes of L.'s Sexual Method. In the former of these classes, the number four, in the other, the number five, is predominant; and, as both covers are present, the opposition and alternation alluded to, becomes distinctly visible."‡ Notwithstanding what has been said, there is, on many occasions, a great difficulty in distinguishing the corolla from the perianth. L. himself confesses, that Nature does not seem to have placed any absolute limits between the calyx and the corolla.§ This, I think, must be admitted as a well founded position; especially if it be not true, that the calyx is exclusively derived from the outer, and the corolla from the inner bark. The learned Mr. A. L. De Jussieu, defines the corolla to be that cover of the flower, "which is surrounded by the calyx, or very rarely naked; is a continuation of the liber, or inner bark, and not of the cortex or outer bark, of the peduncle; is not permanent, but commonly falls off with

* See Plate IV.

† See a figure and description of this plant, in the *Stirpes Novæ* of L'Heritier. Fasc. II. p. 33, 34. pl. xvii.

‡ Milne's Botanical Dictionary, &c. art. Corolla. See also Philosophia Botanica, &c. p. 57, 58. § 90.

§ Philosophia Botanica, &c. p. 58, § 90.

the stamens; which involves or crowns the fruit, but never grows fast to it; and which almost always has its segments or divisions ranged alternately with the stamens." From this view of the subject, the painted petals of the Narcissus are regarded by Jussieu as a true perianth; as, indeed, Tournefort* had taught a long time ago; and by the same rule, the Hyacinth, and other lilliaceous plants, very nearly allied to the Narcissus, are furnished with a perianth, but are destitute of the corolla.† Mr. Adanson, a botanist of great learning, has also observed, that in the lilliaceous plants, what is called by L. the corolla, is, in reality, a perianth, according to the very principles of the Swedish naturalist.

L. has not only acknowledged the difficulty of distinguishing the calyx from the corolla, but in his different works he has confounded these two parts with each other. Thus, in his *Genera Plantarum*, that part which he names the corolla of Rhamnus, he denominates the calyx in the *Systema Vegetabilium*. Again, in his *Genera*, he calls the cover of Polygonum a calyx, or perianth; but in the *Systema Vegetabilium*, he calls it the corolla. Other instances of a like kind might be pointed out. I may add, that L. calls the cover of Phytolacca,‡ the corolla. But this cover is unquestionably a calyx, if any regard be due to the Linnæan rule of the relative disposition of the stamens, and the parts of the cover. Sensible of the great difficulty which not unfrequently occurs in distinguishing the corolla from the calyx, the late learned Nat. Jos. De Necker, has called§ both the corolla and the calyx by one name, viz. *Perigynanda*,‖ a name derived from the Greek, and signifies the envelope, the cover, or wrapper of the stamens, and the pistils. Our author distinguishes the perigynanda, when there are two covers, into the outer and the inner. The inner answers to the corolla, and the outer to the calyx of L. Hedwig, who is generally supposed to have disproved the ideas of L. concerning the origin of the calyx and corolla from the outer and the inner bark of the stem, denotes both the calyx aud the corolla by the name of *Perigonium*.¶ When there are two coverings (the calyx and corolla of L.) he designates one by the name of the *internal* perigonium, and the other by the name of the *external* perigonium. When there are three covers, as is the case in Morina, several malvaceous plants, &c., he calls the third one the *intermediate* perigonium. I have said that "the corolla, according to L., consists of two parts, viz. the *Petalum*, or Petal, and the *Nectarium*,

* Isagoge in Rem Herbariam. p. 72.

† Genera Plantarum secundum Ordines Naturales Disposita, &c. Introductio. p. xiii. Parisiis : 1789.

‡ See Plate XVII. Fig. 4. A. B.

§ In his Corollarium ad Philosophiam Botanicam Linnæi spectans, &c. &c. in his Phytozoologie Philosophique, &c. and other works.

‖ Perigynanda, from περι, around, γυνη, a woman, and ανηρ a man.

¶ *Perigonium*, from περι, about, and γονος, seed.

or Nectary." The petal constitutes the principal part of the corolla. It surrounds both the stamens and the pistils, or the male and female organs of generation. It consists of one or more pieces. According to the number of its petals, the corolla has received the following names. 1. *corolla monopetala*, one-petalled, or monopetalous, consisting of only one petal; as in Convolvulus,* Tobacco,† and many others. 2. *corolla dipetala*, dipetalous, or two-petalled; as in Commelina,‡ Circæa, and others. 3. *corolla tripetala*, three-petalled; consisting of three distinct petals; as in Sagittaria,§ Alisma, &c. 4. *corolla tetrapetala*, tetrapetalous, or four-petalled; as in the plants of the class Tetradynamia. 5. *corolla pentapetala*, or five petalled; consisting of five distinct petals, as in Marsh-Marygold, the *Umbellatæ*, &c. 6. *corolla hexapetala*, hexapetalous; or six-petalled; consisting of six petals; as in Lily, Tulip, Amaryllis, Pancratium, &c. 7. *corolla polypetala*, polypetalous, consisting of many petals. (This term is sometimes used by L., in opposition to the term monopetalous. By many writers it has been put for a corolla of more than six petals.) Of the polypetalous plants, some have nine petals, as the Liriodendron, and some an indefinite number, as Water-Lily, and Globe-Ranunculus. When the corolla consists of only one piece, as in the monopetalous corolla, the whole corolla, in the Linnæan sense of the word, is a petal. A flower which has no petals, or corolla, is termed by the botanists, *apetalus*, or *apetalus flos*, an apetalous flower. This term was adopted by L. from Tournefort. It is equivalent to the term *imperfectus*, or imperfect, of Rivinus, Knaut, and Pontedera: the term *stamineus* of Ray; the *incompletus* of Vaillant; and the *capillaceous* of some other botanists. The existence of the apetalous flowers has been denied by Christian Knaut.‖ But we well know that there are not a few vegetables whose flowers are entirely destitute of the petals. If the notions of Mr. Jussieu and some other botanists, concerning the calyx and the corolla, be admitted as just, it must then be granted, that very many plants, and some of them the most beautiful with which we are acquainted, are strictly apetalous.

The number of petals of which a corolla consists is determined from the base of the corolla. The rule of Rivinus is to reckon as many petals as the parts into which the flower, when it falls, resolves itself. This criterion will in most instances be found very exact. But in some instances it is found to be insufficient for our purpose. For the corolla of the Vaccinium Oxycoccos, or Cranberry, is unquestionably only one-petalled; but this flower, upon falling, resolves itself into four distinct leaves. From the difficulty that occurs in some instances of determining whether a corolla consists of one or more petals, we find that Tournefort reckons the corolla of the Mallow-tribe of plants monope-

* See Plate XI. Fig. 3.

† See Plate XI. Fig. 1.

‡ See Plate X. Fig. 1.

§ See Plate XVIII.

‖ In his Methodus Plantarum genuina. Hallæ: 1716.

talous; whilst L. considers it as pentapetalous. *a.* Different names are assigned to different parts of the corolla. Such are the following. 1. The *tubus*, or tube, is the lower part of a monopetalous corolla; as in Tobacco, &c. 2. The *unguis*, or claw, is the lower part of a many-petalled corolla, by which it is fixed to the receptacle; as in Lily, &c. 3. The *limbus*, or limb, is the border, or upper dilated part of a monopetalous corolla. 4. The *lamina*, or border, the upper, spreading part of a many-petalled corolla. (L. has not uniformly used the term *limbus*, in one sense, for he sometimes employs it for the dilated part of a many-petalled corolla. *b.* In regard to its divisions, the corolla is, 1. *bifida*, bifid, or two-cleft; when each petal is divided into two; as in Chickweed, and Enchanter's Nightshade. 2. *trifida*, three-cleft; when each petal is divided into three parts; as in Holosteum, and Hypecoum. 3. *tetrafida*, four-cleft; as in Cucubalus.* 4. *quinquefida*, five-cleft; as in Basard-Rocket. 5. *multifida*, many-cleft; as in Convolvulus Soldanella. (This term is equivalent to the term *laciniatus flos* of Tournefort.) 6. *bipartita*, two-parted; simple, but divided almost down to the base. 7. *tripartita*, three-parted, simple, but divided into three parts, almost down to the base. 8. *laciniata*, laciniated; divided into segments. *c.* In respect to equality, the corolla is, 1. *regularis*, regular; equal in the figure, size, and proportion of the parts; as in Privet, Lilac, Jasmin, &c. 2. *irregularis*, irregular; when the parts of the limb differ in figure, magnitude, or proportion; as in Aconite, Lupin, and Dead-Nettle. 3. *inæqualis*, unequal; having the parts corresponding, not in size, but proportion; as in Butomus umbellatus.† 4. *æqualis*, equal; when the petals are of the same size and figure; as in Primula, Limosella, &c. (There does not appear to be any essential difference between the terms *æqualis* and *regularis:* and, perhaps, as Dr. Martyn observes, the term regular expresses the idea better.) 5. *difformis*, difform, anomalous, or irregular; when the petals, or their segments, are of different forms. *d.* In respect to figure, the corolla is, 1. *globosa*, globose, globular, or spherical; round like a ball; as in Trollius, or Globe-Ranunculus. 2. *campanulata*, campanulate, bell-shaped, or bell-formed; swelling or bellying out, without any tube; as in the Campanula, Convolvulus,‡ Atropa, and many others. (This term is, in strict propriety, applied to the monopetalous corollas only: yet, sometimes it is extended also to flowers that are polypetalous. 3. *infundibuliformis*, funnel-shaped; having a conical border rising from a tube; as in Lithospermum, Stramonium, Henbane, Tobacco,§ and many others. 4. *hypocrateriformis*, salver-shaped; rising from a tube with a flat border; as in some of the plants called *Asperifoliæ;* in Diapensia, Aretia, Androsace, Hottonia, Phlox, Samolus, &c. 5. *rotata*, wheel-

* See Plate XVII. Fig. 3.

† See Plate XVI. Fig. 3. According to Jussieu, the cover of Butomus is a calyx, or perianth.

‡ See Plate XI. Fig. 3.

§ See Plate XI. Fig. 1.

shaped, spreading flat without any tube; as in Borago, Veronica,* Physalis,† Verbascum, and others. 6. *cyathiformis*, cyathiform, glass-shaped, or cup-shaped; cylindrical, but widening a little at the top. 7. *urceolata*, pitcher-shaped, bellying out like a pitcher. 8. *ringens*, ringent, irregular, gaping with two distinct lips; a one-petalled corolla, the border of which is commonly divided into two parts, to which the botanists have given the names of upper and lower lip. The former is sometimes called the *galea*, or helmet: the latter, the *barba*, or beard. The opening between the two lips is named *rictus*, or the gap: the opening of the tube, *faux*, the throat or jaws: the prominent swelling in the throat, *palatum*, or the palate; and the upper part of the tube, *collum*, or the neck. Most of the flowers in the fourteenth class of the Sexual System, Didynamia, are furnished with this species of corolla.‡ 9. *personata*, personate, or masked: said by L. to be a species of ringent corolla, but closed between the lips by the palate. "But surely (as Dr. Martyn observes,) ringent, or gaping with the lips closed, is a contradiction in terms. It would be better to define it a species of labiate corolla, which has the lip closed." 10. *cruciata* or *cruciformis*, cruciform or cross shaped; consisting of four equal petals, which spread out in form of a cross. This species of corolla is exemplified in most of the plants of L.'s fifteenth class, *Tetradynamia*.§ 11. *papilionacea*, papilionaceous, or Butterfly-shaped; irregular, and most commonly consisting of four petals, to which L. has given three different names: viz. the *carina*, the *vexillum*, and the *alæ*. The carina, or keel, is the lower petal, which is shaped somewhat like a boat; the vexillum, or standard, is the upper petal, which spreads and rises upwards; and the alæ, or wings, are the two lateral petals, which stand singly, being separated by the keel. 12. *rosacea*, rosaceous, or rose-like; consisting of four or more regular petals, which are inserted into the receptacle by a short and broad claw; as in the Wild-Rose. (To plants which are furnished with this species of corolla, Tournefort has given the name of *Rosacei*. They constitute his sixth class.) 13. *undulata*, waved or undulated; the surface rising and falling in waves, or obtusely, not in angles; as in Gloriosa superba, and Gloriosa simplex. 14. *plicata*, plaited; or folded like a fan; as in Convolvulus. 15. *revoluta*, revolute, rolled back or downwards; having the petals rolled back; as in Asparagus, Medeola,‖ and Lilium.¶ 16. *torta*, twisted; as in Nerium, Asclepias, Vinca, &c. *e*. In respect to its margin, the corolla is, 1. *crenata*, crenate; as in Linum, Dianthus chinensis, &c. 2. *serrata*, serrate; as in Tilia, Alisma, &c. 3. *ciliata*, ciliate; as in Rue, Menyanthes, Tropœolum, Gentiana, ciliata, &c. (These terms have already been explained under the head of the nomenclature of leaves.) *f*. In respect to its surface, the corolla is, 1. *villosa*, villose. 2. *tomentosa*,

* See Plate IX. Fig. 2.
† See Plate XI. Fig. 2.
‡ See Plate XIX. fig. 1.
§ See Plate XIX. fig 3.
‖ See Plate XIV.
¶ See Plate XIII. fig. 2.

tomentose. 3. *sericea*, silky, or covered with very soft hairs, pressed close to the surface. 4. *pilosa*, hairy. 5. *barbata*, bearded; as in Dianthus barbatus. 6. *imberbis*, beardless: opposed to bearded. 7. *cristata*, crested; furnished with an appendage, like a crest or tuft; as in Polygala, Iris cristata, &c. *g*. In respect to its proportion, the corolla is, 1. *longissima*, very long; several times longer than the calyx; as in Lobelia longiflora, &c. 2. *brevissima*, very short; not as long as the calyx; as in Sagina procumbens, &c. *h*. In respect to its situation, the corolla is, 1. *supera*, superior; having its receptacle above the germ. 2. *infera*, inferior; having its receptacle below the germ. *i*. In point of duration, the corolla is, 1. *caduca*, caducous; continuing only until the expansion of the flower, and then falling off; as in Herb-Christopher, and Meadow-Rue. 2. *decidua*, deciduous; when the petals fall off with the rest of the flower. 3. *persistens*, permanent; continuing until the fruit has attained to maturity; as in Water-Lily. 4. *marcescens*, withering or shrivelling; withering on the stalk, without dropping; as in Campanula, Orchis, Cucumber, Gourd, Bryony, &c.

In some plants, even of the same species, the carolla is very caducous, or transitory; in others, it is more permanent. We are not acquainted with all the circumstances which thus essentially vary the longevity of the corolla. It is, however, a well known fact, that double flowers, in general, last much longer than single ones. Thus, in single Poppies, the corolla falls off in a few hours, whilst in double ones it lasts for several days.* The double blossoms of the Cherry last much longer than the single blossoms of the same tree. It would, indeed, seem to be a general law of nature, that a longer duration of life is conceded to those vegetables, as well as animals, which are prohibited by their structure, or other circumstances, from the function of generation. In double blossoms, the organs of generation being obliterated, impregnation cannot take place; but in single blossoms, the parts being perfect, there is no obstacle to the generative act. In like manner we find that the mule, which (in general at least) is not fertile, lives longer than the horse or the ass, by which he is begotten; and it has long since been observed, that the term of life of the locust and other species of insects, as well as of various species of birds, may be very considerably protracted by prohibiting them from all intercourse with their respective females. *k*. In respect to its composition, the corolla is, 1. *composita*, compound; consisting of several florets, included within a common perianth, and sitting upon a common receptacle; as in the plants of the class Syngenesia. 2. *ligulata*, ligulate, or strap-shaped; when the florets have their corollets flat, spreading out towards the end, with the base only tubular; as in the plants of the first order of Syngenesia.† 3. *tubulata*, tubulous; when all the corollets of the florets are tubular and nearly equal. 4. *radiata*, radiate, consisting of a disk, in which the

* Dr. James Edward Smith.
† See Plate XXII.

corollets or florets are tubular and also regular; and of a ray in which the florets are irregular and commonly ligulate. *l.* In regard to its colour, the corolla of different vegetables assumes almost every known colour. L., ever in pursuit of analogies, has distinguished the corolla by the name of *auleum floris*, or palace in which the nuptials of the plant are celebrated. But this species of language teaches us nothing very determinate concerning the uses of the corolla. Our author has also observed that the corolla serves as wings to waft the flower about, and thus to assist in the business of impregnation. It seems highly probable that one use, among others, of the corolla, is that of sheltering and defending the stamens and other important parts, which are situated within this beautiful structure. But it is by no means probable that this is the only use of the corolla. Sprengel observes that the corolla is "an attraction to insects, and a convenient seat or bed for them while extracting the honey and promoting the impregnation of the flower."* But who will seriously believe that Nature has exerted so much care and skill in the construction of the beautiful petals of flowers, merely to form a palace for insects, whilst they are aiding in a work which in innumerable instances, is fully accomplished without the least of insectile aid? Dr. Darwin is of opinion that the corolla forms a pulmonary system "totally independent of the green foliage," and that this respiratory system belongs to the sexual or amatorial parts of the fructification only! He asserts that each petal is furnished with an artery "which conveys the vegetable blood to its extremities, exposing it to the light and air under a delicate moist membrane, covering the internal surface of the petal, where it often changes its colour, as is beautifully seen in some party-coloured Poppies, though it is probable (he observes) that some of the iridescent colours of flowers may be owing to the different degrees of tenuity of the exterior membrane of the petal, refracting the light like soap-bubbles. The vegetable blood (continues our learned author) is then collected at the corol-arteries, and returned by correspondent veins, exactly as in the green foliage, for the sustenance of the anthers, and stigmas, and for the important secretions of honey, wax, essential oil, and the prolific dust of the anthers, and thus constitutes a pulmonary organ." In support of this opinion Dr. Darwin has adduced several very ingenious arguments, for the full exposition of which I must refer to his *Phytologia*,† a work replete with learning, and marked in every page with the genius of the British Lucretius. It must be confessed, however, that much of mere hypothesis is attached to Darwin's observations concerning the uses of the parts of vegetables. He has too frequently assumed, as points completely established, points that are still involved in great uncertainty. Thus, a fundamental part of this author's reasoning concerning the use of the corolla, is the assumption of the fact, that in this part of the fructification there is a twofold system of vessels, corresponding to the pulmonary artery and veins of animals.

* Sprengel, as quoted by Dr. J. E. Smith. † Sect. IV.

Now, many experiments which I have made, compel me to entertain some doubts relative to the existence of an arterial and venal system in the corolla. What I have already said concerning the leaves, may, with equal propriety, be extended to the corolla. I have often succeeded in colouring this part of the plant with the juice of the Phytolacca, and other colouring matters: but I have not been able to convince myself that the colouring matter is exclusively carried, in the first instance, along the upper surface of the corolla; and I never could decidedly perceive that it was returned by a venous system on the under side of the petals. I do not mean, however, to deny the existence of arteries and veins in the corolla. I wish to proceed with caution. Many experiments remain to be made before the uses of the corolla can be completely demonstrated to the satisfaction of naturalists and philosophers. I am disposed, in the meanwhile, to believe that both this part and the calyx are essentially concerned in the office of vegetable respiration. Indeed, as nature does not seem to have drawn any certain line of discrimination between the calyx and the corolla, it must, perhaps, be admitted, that both of these parts perform the same office, whatever that office may be. I have already particularly mentioned the curious fact of the longer duration of the double flowers, than of single flowers, in the same species of plant. The ingenious Dr. Smith thinks it probable that this circumstance, "combined with other observations," may "lead to a discovery of the real use of the corolla of plants, and the share it has in the impregnation."* I shall not pretend to determine how far there may be a solid foundation for this idea. But the fact itself is very interesting, and will be again reverted to in the sections on vegetable life and generation. The importance of the corolla, as an organ essentially concerned in the business of respiration, or in that of impregnation, is perhaps *somewhat* diminished by the following fact. Many plants, in certain situations of climate, heat, &c. are observed to drop all, or the greater number of their petals; and yet their seeds ripen, and come to full perfection. Such flowers are called mutilated flowers (*mutilus flos,*) and their mutilation has generally been ascribed to the agency of heat. This is doubtless a frequent cause of the falling of the petals of plants. But it cannot be the only cause: for some of the plants which are natives of warm and temperate climates, are observed to drop their petals in cold climates. Indeed, L. has asserted that the falling of the petals is generally owing to a deficiency of the requisite heat.† He mentions the following plants as instances of *flores mutilati*; viz. Ipomoea hepaticæfolia, Campanula Pentagonia, Ruellia clandestina, Violæ (Violets of various species,) Tussilago Anandria, and Lychnis apetala. To this list may be added the following plants, viz. Campanula perfoliata, Salvia verbenaca, Silene portensis, Cistus salicifolius,

* Philosophical Transactions for 1788. See also Tracts relating to Natural History, p. 177, 178. London: 1798.

† Philosophia Botanica, &c. p. 79, 80. § 119.

Cistus guttatus, Lamium amplexicaule, and many others. The learned Mr. Adanson informs us that the following plants lose their petals at Paris, viz. Glaux maritima, Peplis, and Ammannia. In investigating the characters of vegetables, a knowledge of the various forms and appearances that are assumed by the calyx and the corolla is indispensibly necessary. As this subject will be more particularly treated of in a future part of this work, it is the less necessary to dwell upon it in this place. In drawing the generic characters of vegetables, the different species of calyx and corolla are constantly attended to by L. and all other modern botanists. In many instances these parts even afford excellent marks for the discrimination of the species. Neither the calyx nor the corolla are ever essentially regarded by L. in the classical or ordinal characters of his Sexual System. It is to be observed, however, that this illustrious naturalist has founded a method of plants exclusively upon the form and other circumstances of the calyx. To this method, which he published in 1737, he has given the name of *methodus calycina.* The method of Magnol, a Professor, at Montpelier, can hardly be called a method founded on the calyx. L., however, mentions Magnol, along with himself, among the Calycistæ, or those botanists who have founded their classes upon the calyx. With respect to the corolla, many botanists have founded the classes, or primary divisions, of their systems, entirely upon the regularity, the figure, the number, and other circumstances of the petals. The most celebrated systems of this kind are those of Augustus Quirinus Rivinus, and Joseph Pitton Tournefort. The method of Rivinus proceeds upon the circumstance of the regularity and the number of the petals. That of Tournefort is founded upon the figure and regularity of the petal. Both of these methods are now universally neglected. They have given way, in the revolutions of science, to the more difficult Sexual System of L. But genuine botanists will continue to regard with some attention the arrangements of these Corollistæ, as L. is pleased to denominate them.* System is a slippery thing. The time may again arrive when the method of Tournefort will maintain a station, if not as elevated as it once did, at least much more elevated than it does at present. The Sexual System of L. cannot be immortal. It will, at some future period, be deserted for a system more agreeable to the scheme or intentions of nature.

III. THE NECTARY.—L. defines the nectary "the melliferous part of the vegetable peculiar to the flower;" it secretes or contains a peculiar fluid, the honey of the plant, which constitutes the principal food of bees, and various other species of insects.

He assumes to himself the honour of having first recognized this part

* L. has given this name (which, it is evident, is derived from the word corolla,) to those systematic botanists, who have distributed vegetables according to the regularity, the figure, and other circumstances, of the corolla. Some of the most eminent botanists have been Corollistæ.

in the vegetable structure. "*Nectarium* (says he) ne nomine notum erat, antequam idem determinavimus."* But it is certain that both Tournefort and Sebastian Vaillant had noticed the nectary in certain species of plants; the first of these celebrated men before the birth of L., and the last, when the Swede was not more than ten years old. In 1694 Tournefort observed the nectary in the Passion-flower, the Asclepias, or Swallow-wort, and some other plants; and in 1718, Vaillant, who was both a man of genius and an able botanist, noticed it, and regarded it as a part depending upon the corolla or petals; but which did not, in his opinion, merit any particular appellation.

To the part of which I am speaking, the English writers have given different names. By some† it has been called the "honey-cup." But this name cannot, with propriety, be applied to every species of nectarium, since, in many plants, this part bears no resemblance whatever to a cup, or vessel of any kind. To the term nectary, as a generic term equivalent to the Latin nectarium,‡ there is less objection, especially as the word nectar, applied to a sweet or honied liquor, is so familiar in the English language; as are also the words "nectared," "nectareous," and "nectarine."

a. The nectary assumes a variety of forms in different species of vegetables. Thus, 1. in many flowers it is shaped like a horn, or the spur of a cock. This is the *nectarium calcaratum, corniculatum*, or *cornutum*, the spurred, spur-shaped, or horned-nectary; of which we have examples in the following vegetables, viz. Valerian, Water-Milfoil, Butter-wort, Calves-snout, Lark-spur, Violet, Fumatory, Balsam, and Orchis. 2. The *nectarium scrotiforme*, or purse-like nectary, is somewhat globular, with a depressed line in the middle. 3. *nectarium ovatum*, or ovate nectary. 4. *nectarium turbinatum*, or turbinate nectary; and 5. *nectarium carinatum*, or keeled nectary. This kind of nectary, being entirely distinct from the petals, is denominated *nectarium proprium*, or proper nectary. *b*. In some plants the nectary is really a part of the corolla, since it lies within the substance of the petals. The following plants are instances of this kind of nectary, viz. Fritillaria, Lilium, Swertia, Iris, Hermannia, Uvularia, Hydrophyllum, Myosurus, Ranunculus, Bromelia, Erythronium, Berberis, and the wonderful Vallisneria. This is what L. calls *nectarium petallinum*, or petalline nectary. *c*. In many plants the nectary is placed in a series or row, within the petals or corolla, and yet is entirely unconnected with their substance. A nectary of this kind is said by L. to crown the corolla. The following plants, among many others, fur-

* Philosophia Botanica, &c. p. 125, § 181.

† Dr. Darwin, &c.

‡ "Those who prefer the Latin termination, use *nectaria* in the plural, which is not English. Why do they not use *filamenta*, *stigmata*, &c.?" Professor Martyn.

nish examples of this kind of nectary, viz. Passiflora,* Narcissus, Pancratium, Olax, Lychnis, Silene, Stapelia, Asclepias, Cynanchum, Nepenthes, Cherleria, Clusia, Hamamelis, Diosma. *d.* In the following plants the nectary is situated upon and makes a part of the calyx instead of the corolla: viz. Tropæolum, Monotropa, Biscutella, and Malpighia. This is the *nectarium calycinum*, or calycine nectary. *e.* In some plants the nectary is situated upon the anthers, or summits of the stamens. Hence one of these plants, the Bastard flower-fence of the English, has received the generic name of Adenanthera. *f.* The nectary of many plants is placed upon the filaments. This is the case in Laurus, Dictamnus, Zygophyllum, Commelina,† Mirabilis, Plumbago, Campanula, Roella, and others. *g.* In the following plants the nectary is placed upon the germ, or seed-bud: viz. Hyacinth, Flowering-Rush, Stock July-flower, and Rocket. This is the *nectarium pistillaceum*, or pistallaceous nectary. *h.* In Honey-flower, Orpine, Buckwheat, Collinsonia, or Horse-weed; Lathræa, Navel-wort, Mercury, Clutia, Kiggelaria, Sea-side Laurel, and several others, the nectary is placed upon, or attached to, the common receptacle. This is the *nectarium receptaculaceum*, or receptacular nectary. *i.* L. considers, as a true nectarium, the tube, or lower part of the monopetalous, or one-petalled flowers, such as Datura, Nicotiana, &c., because, in general, this part contains, and probably forms, a sweet or honied liquor, which constitutes one of the alimentary articles of bees, phalænæ, and other insects. *k.* In many plants, such as Ginger, Turmerick, Reseda, Grewia, Nettle, Bastard Orpine, Vanilla, Willow, &c., the nectary is of a singular construction, and cannot, with propriety, be referred to any of the preceding heads.

L. affirms that those plants which have their nectary distinct from the petals, that is, not lodged within the substance of the petals, are generally poisonous. The following plants are adduced as examples of this observation: viz. Monkshood, Hellebore, Columbine, Fennel-flower, Parnassia, Barren-wort, Oleander, Marvel of Peru, Bean-Caper, Succulent Swallow-wort, Fraxinella, and Honey-flower. Some of these plants are indeed poisonous, such as Monkshood, Oleander, Hellebore, &c. But I am inclined to think that the observation of L. is not of much practical importance; since it is certain that some of the plants which he has introduced into the list are by no means highly deleterious; and their honey does not seem to contain any noxious quality. F. A. Cartheuser, a long time ago, denied the truth of the Linnæan position. S. A. Spielmann asserts, that there is nothing poisonous in the flowers of the Aconitum, or Monkshood.‡ Certain it is that bees extract the honey of this plant, as they do also from the nectaries of Aquilegia vulgaris, and Aquilegia canadensis, or Common, and Canadian Columbine. It must, however, be admitted, that we

* See Plate XXV. † See Plate X. Fig. 1.

‡ De Aconito. Argentorati: 1769: 8vo.

cannot safely infer the innocent nature of a vegetable, because bees extract, and receive no injury from, the honey of such a vegetable. It has always appeared to me that L. has been less happy, and has discovered less talent and precision in his history of the nectary, than in his account of most of the other parts of the vegetable. Notwithstanding his assertion, that the nectary is a part of the corolla, it is certain that all flowers are not provided with this organ or appendage, and in many plants which are provided with it there is no immediate connection whatever between it and the corolla. "L. (to use the words of a very sensible botanist) might, with equal propriety, have termed it, (the nectary) a part or appendage of the stamina, calyx, or pointal, as the appearance in question is confined to no particular part of the flower, but is as various in point of situation as of form. The truth is, the term *nectarium* is exceedingly vague; and, if any determinate meaning can be affixed to it, is expressive of all the singularities which are observed in the different parts of flowers."* Dr. Smith observes, that "L. called every thing, not calyx, petals, or organs of propagation, *nectarium*."† It may be added, that what L. calls nectaria, some other writers have thought proper to denominate petals. Thus, Vaillant denominated the nectaries of the Nigella and Aquilegia, petals. The coloured leaves of these plants, which are now regarded as petals, the French botanist called the calyx or flower-cup. G. C. Oeder follows Vaillant in considering the nectaries of many of the plants of the class *Polyandria* as petals. Moenich calls these spurred or horned nectaries, of which I am speaking, *parapetala*. L. has, moreover, sometimes called the abortive or infertile stamens of certain plants, nectaria. In this respect, Mr. L'Heritier has also erred, particularly in drawing the generic character of Erodium.

Upon the whole, the term nectarium is an extremely vague one. I cannot help agreeing with Mr. De Jussieu, that the term should be rejected from the science of Botany. It is greatly to be wished that some person, possessed of the requisite talents, would undertake the investigation of the subject of the various species of nectaries, and arrange these parts under some more appropriate names. Necker restricts the term nectarium to those glandular bodies which occupy the base of the stamens, and secrete a honied liquor. He admits that there are other parts of vegetables which furnish a honied liquor in flowers, but these, he says, are of no consequence in determining the characters of plants.‡ In investigating the genera of plants, a knowledge of the various species of nectarium is of very essential, and indeed, indispensible, consequence. Thus, the essence of the genus Ranunculus consists in its nectary, which is a small prominence that is situated at the unguis, or claw, of each petal of this plant.

* Milne's Botanical Dictionary, &c. article Nectarium.
† Syllabus, &c. p. 23.
‡ Corollarium, &c. p. 13, 14.

The chemical analysis of the honey of the nectaries has been very little attended to. What has been done leads us to believe that this secreted juice (in many plants at least,) contains nothing distinct from sugar or honey. F. A. Cartheuser examined the honey of the nectaria of different plants, particularly that of the Melianthus, or Honey-Flower. He says the honey of this plant is a true honey. Some authors inform us, that the honey of the Melianthus is a stomachic. This would seem to show that it contains some foreign quality, distinct from mere sugar or honey. There is often, however, combined with the honey of plants, a noxious property. This is frequently the property of the plant which secretes the honey. The tube of the flower of the Agave americana contains a great deal of a watery, honey-like fluid, which is sweet, and of an acid nature. This fluid is purgative, and emetic, when exhibited in the dose of two table-spoonsful. The nectar of some plants is entirely refused by the bees. Thus, bees do not touch the honey of the Fritillaria, or Crown-Imperial.* Yet I do not know that any experiments have shown that this honey is noxious to animals. The Fritillaria is, indeed, a poisonous plant. But we are told that the Willow-wren runs up the stem of this fine vegetable, and sips the honey. We know that the honey which is procured from certain vegetables is poisonous. The Greek† and Roman‡ naturalists speak of a poisonous honey; and we are acquainted with some of the plants from which this honey is procured. In North America, an intoxicating and deleterious honey is procured from the flowers of the Kalmia angustifolia, and other vegetables. In the *Transactions* of the American Philosophical Society,§ I have inserted a memoir on the "Poisonous and Injurious Honey of North America." To this memoir I beg leave to refer the reader. It has been observed that the nectar of plants "tempts insects to assist the impregnation."‖ This is, no doubt, the case. But it may well be questioned, whether this is the final end, or intention of nature, in furnishing plants with the nectary fluid. We find that the nectar of some plants is altogether untouched by insects. Such as Fritillaria. Besides, in very many plants, which abound in nectar, the styles, from their proportion or situation, are readily, nay, necessarily impregnated, without any insectile assistance. In Fritillaria, the aid of insects cannot be wanted. I presume that the business of vegetable impregnation would proceed very well, even were the whole world of insects entirely annihilated. So little *necessary* dependence, in this respect at least, is there between the great worlds of animals and vegetables. So feeble, so visionary, is the theory of those philosophers, who have imagined, that Nature has connected together, in necessary dependence, her innumerable productions, like links in a chain of man's

* J. Duverney, Linnæus, &c.
† Xenophon, Dioscorides, Diodorus Siculus, &c.
‡ Pliny.
§ Vol. V. No. VII.
‖ Dr. I. E. Smith.

construction! The botanists have found no small difficulty in determining the real use of the nectaries, and of the honied liquor which they contain. Julius Pontedera imagined that the honey of plants is equivalent to the *liquor amnii*, or liquor of the amnion, in pregnant animals, and that it enters the fertile or impregnated seeds.* Here it might be observed, that the importance of the liquor amnii, as an agent in the nutrition of the fetus, is not admitted by the generality of the modern physiologists.† It is, however, of more importance, to observe, that the hypothesis of Pontedera is rendered improbable by this circumstance, that the nectary and the honey which it contains are found in many male flowers, such as those of the Willow and the Nettle, where there are no seeds to be impregnated. Perhaps, however, this does not decidedly show that the nectareous fluid is useless in giving fertility to the seed. It is certain that nature, intent upon a specific object or end, sometimes bestows upon the different sexes of a species the same organs. Thus, she concedes to the males and females of certain animals the secretory organs, which we call mammae, or breasts. In both sexes these organs sometimes secrete a peculiar fluid, called milk. Yet, this secretion can be required in one of the sexes only. But actual experiments have shown that the nectary is not essentially necessary to the fertility of the seed. We have seen that in many plants the nectaries are distinct from the corolla. The Aconitum, or Monkshood, is one of these plants. The nectaries of this plant were removed, but the seeds were as effectually ripened as though the operation had not been performed.‡ Ludwig supposed that the office of the nectary is to excrete those juices of the plant which are too thick, or gross.§ But neither is this a very satisfactory explanation of the use of the organ. Boehmer supposes that the true nectaries secrete a juice which is necessary to the nutriment of the plant.|| Dr. Darwin has proposed a new and very ingenious idea concerning the use of the nectary of vegetables. "The nectary, or honey-cup, he says, is evidently an appendage to the corol, and is the reservoir of the honey, which is secreted by an appropriate gland from the blood, after its oxygenation in the corol———and is absorbed for nutriment by the sexual parts of the flower." It is the opinion of this writer, that this saccharine secretion serves as food to the anthers and stigmas. Let us see upon what grounds this idea proceeds. In many tribes of insects, as in the silk-worm, moths, butterflies, &c., the male and female parents die as soon as the eggs are impregnated and excluded, the eggs remaining to be perfected

* Anthologia, seu de Floris Natura, &c. Patavii: 1720. 4to.

† Of late, however, Dr. Darwin has endeavoured to show, that the liquor amnii is of real importance in the nutrition of the fetus. See his Zoonomia, &c. Vol. 1. Sect. XXXVIII.

‡ F. A. Cartheuser.

§ Institutiones Regni Vegetabilis, &c. 1757. 8vo.

|| Dissertatio Inauguralis de Nectariis Florum. Wittemberg: 1758. 4to.

and hatched at some future period. In vegetables we observe nearly the same phenomenon. In this family of animated objects, the stamens and pistils fall off and die, as soon as the seeds are impregnated, and along with these genital parts, the petals and honey-cups. It is observed, that the insects which I have mentioned, so soon as they acquire the passion and the apparatus for the reproduction of their species, lose the power of feeding upon leaves, as they did before, and become nourished by honey alone.

"Hence (continues our author,) we acquire a strong analogy for the use of the nectary, or secretion of honey, in the vegetable economy; which is, that the male parts of flowers, and the female parts, as soon as they leave their fetus-state, expanding their petals, (which constitute their lungs,) become sensible to the passion, and gain the apparatus for the reproduction of their species; and are fed and nourished with honey like the insects above described; and that hence the nectary begins its office of producing honey, and dies, or ceases to produce honey, at the same time with the birth and death of the anthers, and the stigmas; which, whether existing in the same, or in different flowers, are separate and distinct animated beings. Previous to this time, the anthers with their filaments, and the stigmas with their styles, are in their fetus state sustained in some plants by their umbilical vessels, like the unexpanded leaf-buds, as in Colchicum autumnale, and Daphne Mezereon; and in other plants by the bractes, or floral-leaves, as in Rhubarb, which are expanded long before the opening of the flower; the seeds at the same time existing in the vegetable womb, yet unimpregnated, and the dust yet unripe in the cells of the anthers. After this period the petals become expanded,"———the umbilical vessels, which before nourished the anthers and the stigmas, coalesce, or cease to nourish them; and they acquire blood more oxygenated by the air, obtain the passion and power of reproduction, are sensible to heat, and light, and moisture, and to mechanic stimulus, and become, in reality, insects fed with honey; similar in every respect, except that all of them yet known, but the male flowers of Vallisneria,* continue attached to the plant on which they are produced. So water insects (continues our author,) as the gnat, and amphibious animals, as the tad-pole, acquire new ærial lungs, when they leave their infant state for that of puberty. And the numerous tribes of caterpillars are fed upon the common juices of vegetables found in their leaves, till they acquire the organs of reproduction; and then they feed on honey, all I believe except the silk-worm, which in this country (Britain,) takes no nourishment after it becomes a butterfly. And the larva or maggot of the bee, according to the observations of

* We are now acquainted with two species of Vallisnaria, the V. spiralis, and V. Americana. Of this last species, which is a native of many parts of North America, growing abundantly in the river Delaware, &c. &c. I have given a particular account, in a memoir read before the American Philosophical Society, on the 6th of February, 1801.

Mr. Hunter, is fed with raw vegetable matter, called bee-bread, which is collected from the anthers of flowers, and laid up in cells for that purpose, till the maggot becomes a winged bee, acquires greater sensibility, and is fed with honey."* Such is Dr. Darwin's hypothesis concerning the use of the nectar, or honied liquor of plants. The hypothesis is certainly ingenious, and is entitled to the attention of naturalists. But it is merely in the light of an hypothesis that it ought to be viewed. And yet it has already been adopted by some writers, particularly by the ingenious female author of a work entitled *Botanical Dialogues*.† Future experiments will show how far the opinion of the English Philosopher is founded upon a solid basis. I must confess, that very powerful objections to the hypothesis present themselves to my mind. Certainly all plants are not furnished with the organs called nectaries, particularly with those species of nectaries which are known to secrete or contain a honied fluid. Moreover, we have seen that the nectaries of certain species of plants may be entirely removed, without obviously affecting, in any degree, the health or fertility of the plant. When we consider, however, the highly nutritious nature of sugar, honey, and other saccharine matters, it would seem not improbable, that the nectar is really conceded to plants to assist in giving nutriment or strength to them. This opinion is, at least, more philosophical than that of those writers who have imagined that plants are furnished with nectar merely as an alimentary article for insects, or as an incitement for them to give their aid in insuring the fertility of plants.

IV. The Stamen, which some English writers have called the Chive, is defined by L. "an organ for the preparation of the pollen:" "Viscus pro Pollinis præparatione."‡ The stamens, in most flowers, are placed round the seed-bud, and consist, according to L., of three parts, the *Filamentum*, the *Anthera*, and the *Pollen*. In reality, however, the stamen consists of only two parts, the filamentum and the anther, the pollen being merely a matter secreted by, or contained in, the anther.

A. I shall first speak of the Filamentum. This, which receives its name from the Latin word *filum*, a thread, is the more slender, or thread-like part of the stamen which supports the anther, and connects it with the flower. The term filament is equivalent to the term stamen, as employed by Tournefort and other botanists. *a.* The filaments, in respect to number, are very different in different vegetables. Some plants have but one filament, some two, three, &c. &c., whilst some have from twenty to a thousand. *b.* In point of figure, the filament is, 1. *capillare*, capillary; long and fine like a hair. 2. *planum*, flat; having the two surfaces parallel. 3. *cuneiforme*, cuneiform; or wedge-shaped. 4. *spirale*, spiral; ascending in a spiral line. 5. *subulatum*, subulate, or awl-shaped. 6. *emargina-*

* Phytologia, &c. Sect. VII. See also Sect. VI.
† London: 1797. 8vo.
‡ Philosophia Botanica, &c. p. 53. § 86.

tum, emarginate. 7. *reflexum*, reflected. 8. *laciniatum*, laciniated. 9. *dentatum*, toothed. 10. *mutilatum*, mutilated; with the rudiment only of a filament. 11. *castratum*, castrated; elevating a barren anther, or none at all; as in some species of Geranium. *c.* In point of insertion, the filaments are, 1. *calyci opposita*, opposite to the leaflets or segments of the calyx. 2. *calyci alterna*, alternate with the calyx: placed alternately with the leaflets of the calyx. 3. *corollina*, inserted into the corolla. 4. *calycina*, calycine; inserted into the calyx; 5. *receptaculacea*, receptacular; inserted into the receptacle. 6. *nectarina*, nectarine; inserted on the nectary. 7. *stylo inserta*; inserted on the style; as in the plants of the class *Gynandria*.

d. In point of proportion, the filaments are, 1. *æqualia*, equal; all of the same length. 2. *inæqualia*, unequal; some larger than others. 3. *connata*, connate; conjoined into one body, so as to form a tube at the base; as in the plants of the class *Monadelphia*. 4. *longissima*, very long; longer than the corolla. 5. *brevissima*, very short; much shorter than the corolla. 6. *longitudine corollæ*, of the same length as the corolla. 7. *longitudine calycis*, of the same length as the calyx. *e.* In respect to its surface, the filament is, 1. *pilosum*, hairy. 2. *villosum*, villous. 3. *hirsutum*, hirsute. *f.* In respect to its structure, the filament is, 1. *membranaceum*, membranous. 2. *nectariferum*, nectariferous. *g.* In respect to its direction, the filament is, 1. *erectum*, erect. 2. *patens*, spreading. 3. *patentiusculum*, somewhat spreading. 4. *patentissimum*, very much spreading. 5. *arcuatum*, bowed; bent in the form of a bow. 6. *connivens*, converging; approaching the other filaments with the point. 7. *reflexum*, reflected. 8. *declinatum*, declined. 9. *inflexum*, inflected. 10. *flaccidum*, flaccid. 11. *assurgens*, assurgent. 12. *ascendens*, ascending. 13. *recurvum*, recurved. 14. *incurvum*, incurved.

B. The Anther is the second part of the stamen. This is the part which Ray denominated the *Apex*, and Malpighi, *Capsula staminis*. Dr. Grew, and others of the older botanists, called it the Summit, Semet, Pendent, or Tip. "I prefer Anther to Anthera, in English; because we thus avoid any dissension between the learned and unlearned, respecting the pronunciation of the penultima, and the formation of the plural."* L. defines the anther to be a part of the flower, big with pollen, or farina, which it emits or explodes when ripe.† The anther may be defined a capsule or vessel, destined to produce or contain a substance, whose office is the impregnation of the germ or female organ. It commonly forms a part of the stamen, and is usually placed upon the top of the filament. But it must not be forgotten that, in many plants, the anther exists without any filament to support it. *a.* The number of the anthers is very different in different plants. The gene-

* Professor Martyn.

† "*Anthera* pars floris gravida Polline, quod matura dimittit." Philosophia Botanica, &c. p. 53. § 86.

rality of plants have a single anther to each filament. This is the case with most of the plants that are figured in these *Elements*. To this general rule, however, there are many exceptions: viz. 1. Mercurialis, or Mercury, and Ranunculus, have two anthers to each filament. This is what L. denominates *anthera didyma*, or twin anther. 2. Fumaria has three anthers to each filament. 3. Bryonia has five anthers to three filaments. Here a single anther is affixed to one of the filaments, and the remaining four anthers are equally divided between the other two filaments. 4. In the Theobroma, or Chocolate-nut, there are five anthers to each filament. 5. The Pea, the Bean, Vetch, Trefoil, Liquorice, and many other flowers of the class of *Diadelphia*, have, in general, ten anthers to two filaments; or, more properly speaking, to two sets of united stamens. 6. In the Cucurbita, or Gourd, there is one anther common to three filaments. 7. In the Dandelion, Feverfew, Groundsel, and other really compound flowers, of the class of *Syngenesia*, one anther is common to five filaments: or, to speak more properly, five anthers, which are united into a cylinder, are placed upon five distinct and separate filaments. 8. In some plants some of the filaments are terminated by anthers, whilst others are naked, or destitute of these parts. Thus, the two genera; Chelone and Martynia, are furnished with four complete stamens; together with the rudiment of a fifth filament, which is destitute of the anther. Verbena has four filaments, only two of which are antheriferous. The Bignonia Catalpa of L. has two perfect stamens, or stamens with anthers; and three filaments which want the anthers. Other irregularities of this kind will be noticed in the progress of this work. *b*. In point of figure, the anther is, 1. *oblonga*, oblong. 2. *globosa*, globular. 3. *sagittata*, sagittate. 4. *angulata*, angular. 5. *cornuta*, horned. 6. *bicornis*, two-horned. 7. *linearis*, linear. 8. *acuta*, acute. 9. *acutiuscula*, rather acute. 10. *cordata*, cordate. 11. *ovata*, ovate. 12. *hastata*, hastate. 13. *biloba*, two-lobed. 14. *reniformis*, reniform. 15. *bifida*, bifid. 16. *bipartita*, two-parted. 17. *aristata*, awned; ending in an awn. 18. *setifer*, bristle-bearing; ending in a bristle. 19. *rostrata*, rostrate, or beaked; ending in a filiform beak. 20. *truncata*, truncated. 21. *obtusa*, obtuse. 22. *emarginata*, emarginate. 23. *acuminata*, acuminate. 24. *furcata*, forked; divided at the end, and diverging. *c*. In point of direction, the anther is, 1. *erecta*, erect. 2. *rigida*, rigid. 3. *patens*, spreading. 4. *assurgens*, assurgent. 5. *inflexa*, inflected. 6. *nutans*, nodding. 7. *declinata*, declined. 8. *pendula*, pendulous. 9. *incurva*, incurved. 10. *connivens*, converging. 11. *spiraliter contorta*, twisted spirally. *d*. In point of insertion, the anther is, 1. *sessilis*, sessile. 2. *versatilis*, versatile: incumbent, but freely moveable. 3. *adnata*, adnate. 4. *distincta*, distinct; not cohering with other anthers. 5. *connatæ*, connate; when several anthers are conjoined into one. 6. *cylindraceæ*, cylindrical; formed into a cylinder, or equal tube. 7. *tubulatæ*, tubular; coalescing so as to form a tube; as in the compound flowers of the class of *Syn-*

genesia. 8. *cohærentes*, cohering at the base, apex, &c. 9. *incumbens*, incumbent; fixed by the middle upon the filament. 10. *lateralis*, lateral; connected by the whole side to the filament. *e*. In respect to substance, the anther is, 1. *membranacea*, membranous. 2. *depressa*, depressed. 3. *compressa*, compressed. 4. *convexa*, convex. 5. *plana*, flat. 6. *sulcata*, furrowed. 7. *transversim sulcata*, transversely furrowed. 8. *longitudinaliter sulcata*, longitudinally furrowed. 9. *subulata*, subulate. 10. *bilamellata*, bilamellated; with two membranous plates.

f. In respect to measure, the anther is, 1. *filamentis brevior*, shorter than the filaments. 2. *corolla brevior*, shorter than the corolla. 3. *longitudine filamenti*, of the same length as the filament. 4. *longior filamentis*, longer than the filaments. 5. *æquales*, equal; of the same size as one another. 6. *longissima*, very long; much longer than the filament. 7. *brevissima*, very short; much shorter than the filament. *g*. In respect to its place, the anther is, 1. *tecta*, covered; concealed by a scale of the arch, as in the *Asperifoliæ*, or Rough-leaved plants. 2. *inclusa*, enclosed; situated within the throat of the corolla. 3. *nuda*, naked; neither covered nor enclosed. *h*. In respect to its cells and aperture, the anther is, 1. *unilocularis*, one-celled. 2. *bilocularis*, two-celled. 3. *trilocularis*, three-celled, 4. *bivalvis*, two-valved. 5. *didyma*, didymous; gibbous outwardly, with two protuberances. 6. *sterilis*, barren; not forming pollen, or fecundating matter. 7. *deflorata*, deflorate; having ejected, or excluded the pollen. 8. *fœcunda*, fertile, with pollen. 9. *apice dehiscens*, opening at the top. 10. *latere dehiscens*, opening at the side. L. denominates the bursting of the anthers, *Dehiscentia*.* *i*. In respect to situation, 1. the anthers are generally situated upon the tops of the filaments. 2. In some plants, however, the anthers are fixed to the middle or sides of the filaments. 3. In many plants; having no filaments, the anthers adhere to the stigma, or summit of the female organ. 4. In other plants, also destitute of filaments, the anthers are fixed to the receptacle. 5. In some they are situated upon the nectary.

C. The Pollen, which L. calls the third part of the stamen, is the farina, or prolific powder, which is contained in the anthers of flowers, and which, according to the Swedish naturalist, after being moistened with a liquor which is peculiar to, and lodged upon, the stigma, or summit of the female organ, bursts like a bladder, and gives out, elastically, a substance which is imperceptible to the naked eye. This substance L. calls *Fovilla*, or *aura seminalis*. Necker defines the pollen, a collection of minute inflammable globules, in which the "lympha fœcundans, or fecundating fluid, is contained.† The pollen of some plants is certainly inflammable; but in the pollen of many other plants we discover nothing of an inflammable quality. In many plants, such

* *Dehiscentia*, from *dehisco*, to gape, or open wide.

† Corollarium, &c. p. 14.

as Veratrum luteum,* &c., the pollen has a peculiar and powerful smell, very similar to that of certain animal secretions.

The pollen of vegetables is of various colours, but most commonly of the different shades of yellow, orange, red, and purple. It is beautifully conspicuous upon the anthers, or summits, of some flowers, particularly the Tulip, the Lily, &c. When completely matured, and fit for performing the important office for which it is destined, it is readily removed from the anthers, by the application of the finger, or other moist body.

To the naked or unarmed eye, the pollen appears to be a mere inorganic farina, or powder. But when it is subjected to the aid of the microscope, it is found to put on a great variety of forms, in different species of vegetables. These forms, it is asserted, frequently predominate, not only through the different species of a genus, but even through the different genera of a natural family or order. Thus, in Helianthus, or Sunflower, the polleniferous particles assume the appearance of prickly balls or burs. In the Geranium sanguineum, or Bloody Cranesbill, they are like perforated globules of fire; in the Mallows, they resemble wheels furnished with teeth; in the Ricinus communis, or Palma Christi, they are shaped like grains of Wheat; in the Viola tricolour, or Pansies, they are angulated; in the Turkey-Wheat,† they are flat and smooth; in the Borage, like a thin leaf, rolled up; in the Narcissus, reniform, or kidney-shaped; and in the Symphitum, or Comfrey, like double or twin globules.‡ It is unnecessary to pursue this subject through numerous other vegetables, the pollen of which has been particularly examined, through good glasses, by many ingenious naturalists. Tuberville Needham, and other writers have shown, that the pollen of vegetables, upon being put into water, immediately bursts, and scatters its fovilla, or fecundating aura, abroad. The great importance of the pollen, which L. has called the "genitura of the plant," will be very particularly considered in treating of the generation of vegetables.

As the nectar of vegetables is an article of great importance in the nourishment of bees and other insects, so also the powder of the anthers constitutes one of the alimentary articles of bees. These industrious insects visit the flowers of an immense variety of plants, quaffing the nectar, and carrying away upon their thighs great quanties of the pollen. This they lay up, in the cells of their combs, as food for the young bees, whilst in their larva, or maggot-state. To the pollen thus stored up, the name of "bee-bread" has been given, both in Britain and in the United States. This, as has been already observed, is "raw vegetable matter," or pollen, so little altered that it retains its peculiar taste and smell, in the cells of the comb. Thus, we can often tell, by an examination of the bee-bread, from what particular species of plants it has been procured. By thus depriving vegetables of their pollen, there

* Melanthium dioicum? of Walter.

† Zea Mays, or Indian-corn.

‡ J. G. Wahlbom.

can be little doubt, that bees, in many instances, essentially diminish the fertility of plants.* This, perhaps, is more especially the case with respect to many of the plants of the class *Dioecia:* for here, the male and female organs of generation being situated upon distinct individuals, and frequently at a considerable distance from each other, the chances of impregnation are necessarily fewer than in the plants of the hermaphrodite classes, where the males and females are situated, in close vicinity, within the same calyx or corolla. On the other hand, however, it is the opinion of many writers, that bees are no mean agents in favouring the impregnation of vegetables. We shall afterwards see, that the naturalists of the school of L. have frequently been under the *necessity* of availing themselves of the agency of bees to explain some of the difficulties which still obstruct the beautiful doctrine of vegetable generation. By robbing plants of their pollen, do not bees contribute not a little to that vast variety of double blossoms with which our gardens are stocked and beautified? Some facts, and some plausible reasoning, might be urged in support of this conjecture. To the pollen of vegetables and the labour of the bees, mankind are indebted for a very important article, I mean wax, or bees-wax. The celebrated R. A. F. de Reaumur, a long time ago,† asserted, that the pollen of vegetables, after undergoing the digestive process in the stomach of the bee, was converted into wax. This opinion has lately been confirmed by the inquiries of Mr. John Hunter.‡ With respect to the analysis of the pollen and of wax, much still remains to be done by the chemists to complete this subject. Experiments, however, seem to render it probable, that the basis of both of these matters is a fat oil, which, combining with oxygen, passes to the state of a resin. If the nitric or muriatic acids be digested, for a considerable time, upon a fixed oil, this passes to the state of a matter intimately resembling wax. It remains to be proved, what is the precise nature of the matter by which the pollen is converted into wax, in the stomach of the bee. Experiments will, in all probability, show, that the pollen of plants (of many plants at least,) contains a very large portion of oxygen. An anonymous author,§ many years ago, asserted, that the pollen of plants, (by giving out its phlogiston, as he supposed,) brought the calyx of iron to the state of a metal. Tingry discovered that the pollen contains volatile oils, and different essential oils, that are soluble in spirit of wine. The powerful odour and the taste of the pollen of many plants, would lead us to believe that this pro-

* It has been observed, in Pennsylvania, and other parts of the United States, that the bees rob certain species of plants, particularly the Polygonum Fagopyrum, or Buckwheat, of such immense quantities of pollen, that great numbers of the little insects are drowned in crossing our creeks and rivers, owing to the too heavy loads of the powder which they attempt to carry to their hives.

† In the year 1740.

‡ Philosophical Transactions, for the year 1792.

§ See Bibliotheca Botanica, &c. Auctore A. Hallero. Tom. ii. p. 189.

lific matter possesses very active qualities, with respect to the human and other animal bodies; and it is not improbable, that it might be advantageously employed in the treatment of some of our diseases. If I do not greatly mistake, the pollen of some of the *cerealia* is employed as a medicine, in certain diseases, in some parts of Poland. In the study of Botany, it is a point of the utmost importance to be intimately acquainted with every circumstance relative to the stamens, by which I mean the male organs, taken in the aggregate, and consisting of the filaments, the anthers, and the pollen. Without an intimate acquaintance with the natural history of these truly important parts in the vegetable economy, we shall be incapable of understanding that wonderful function, by which the world of vegetables has been thus far preserved from destruction; and by which it will, doubtless, be perpetuated, (with the occasional loss of some species, in future, as heretofore, so long as our globe shall exist,) to serve as the sustenance of man and other animals, and for innumerable other purposes. Nor does the utility of an acquaintance with the stamens terminate here. Upon these organs of the vegetable the great L. has constructed the most essential parts of his Sexual System: the classes, or primary divisions, and many of the orders, or secondary divisions. The twenty-four classes of this celebrated system are founded upon the circumstances of the number, the place of insertion, the proportion, the connection, the disposition, or the absence of the stamens. Hence, it is obvious, that we cannot understand the system of the Swedish naturalist, without a thorough acquaintance with the sexual organs.

V. The Pistullum is the fourth part of the fructification enumerated by L. He defines it, "a viscus or organ adhering to the fruit, for the reception of the pollen." "Viscus fructui adhærens pro Pollinis receptione."* This part, to which the English botanists have given the name of Pistil and Pointal, is the female part of the vegetable, which assumes the appearance of a column, or set of columns, and is commonly situated in the centre of the flower, within the stamens. When perfect, it consists of three parts, the *Germen*, the *Stylus*, and the *Stigma*.

A. The Germen, which is called by the English botanists the Germ, Ovary, or Seed-bud, is the rudiment of the fruit, yet in an embryo-state. It constitutes the lower part, or base of the pistil, and supports the style and the stigma. *a.* The germ varies in respect to number in different plants. Some plants have but one germ, some two, three, &c. &c. whilst some have many. *b.* In point of figure, the germ is, 1 *subrotundum*, roundish. 2. *ovatum*, ovate. 3. *oblongum*, oblong. 4. *turbinatum*, turbinate. 5. *conicum*, conical; in the form of a cone. 6. *lineare*, linear. 7. *cordatum*, cordate. 8. *obcordatum*, obcordate. 9. *globosum*, globular. 10. *fissum*, cleft. 11. *bifidum*, bifid. 12. *trifidum*, trifid. 13. *partitum*, parted. 14. *bipartitum*, two-parted. 15. *angulatum*, angular. 16. *triangulare*, triangular. 17. *didymum*,

* Philosophica Botanica, &c. p. 53. § 86.

didymous. 18. *compressum*, compressed. 19. *acutum*, acute. 20. *rostratum*, beaked. 21. *subulatum*, subulate. *c.* In respect to its surface, the germ is, 1. *scabrum*, rough. 2. *villosum*, villous. 3. *imbricatum*, imbricated. *d.* In regard to its place, the germ is, 1. *superum*, superior; that is, included in the corolla, or the calyx. 2. *inferum*, inferior; placed beneath the corolla, or the calyx. *e.* In respect to its insertion, the germ is, 1. *sessile*, sessile. 2. *pedicellatum*, pedicelled; standing on a pedicel, or footstalk. 3. *setæ insidens*, sitting on a bristle. *f.* In regard to its measure, the germ is 1. *minimum*, very small in proportion to the corolla. 2. *longitudine staminum*, as long as the stamens. 3. *longitudine calycis*, as long as the calyx. 4. *longitudine nectarii*, as long as the nectary. Pursuing his favourite subject of the analogies which subsist between animals and vegetables, L. has denominated the germ, the ovarium, or uterus of plants. To this language I shall offer no objection. We shall afterwards see, that in the germ are contained the embryo-seed of the plant, which pre-exist in this organ, (as do the ova in the ovaria of many, if not all, animals,) and after receiving the influence of the pollen, or powder of the stamens, are rendered fertile, and thus befitted for the important business of the perpetuation of the species.

B. The Stylus,* or Style, is the middle portion of the pistil, which, in many plants, connects the stigma with the germ. I say, in many plants, for the style is not present in all plants, and is not essentially necessary to the generation of the plant. In this respect, it is upon a footing with the filament.

a. The style, as well as the germ, varies in respect to number, in different plants. Some plants have but one style, some two, three, &c. &c., whilst some are furnished with many of these organs. In general, the number of the styles is equal to that of the germs, or ovaries, each germ being furnished with its particular style. This is the structure of the compound flowers, the cone-bearing plants, the Rose, the Ranunculus, the Liriodendron, or Tulip-tree, and many others. 1. To this general rule, however, there are exceptions; that is, there are vegetables which have more than one style to a single germ, or seed-bud. 2. There are other plants, such as the *Asperifoliæ*, and most of the Lip-flowers, which have a single style, common to many germs. 3. In other plants, again, the style at its origin is single, but soon branches out into as many ramifications as there are divisions or cells in the cavity of the germ. We discover this structure in the plants of the two families of Geranium and Mallow, and many of their relations, principally belonging to the class *Monadelphia* of the Sexual System. *b.* In point of proportion, the style is, 1. *longissimus*, very long, with respect to the stamens. 2. *brevissimus*, very short. 3. *longitudine staminum*, as long as the stamens. 4. *crassitie staminum*, as thick as the stamens. 5. *crassus*, thick with respect to the stamens. 6.

* Stylus, from στυλος, a column.

tenuis, slender with respect to the stamens. *c.* In respect to its division, the style is, 1. *simplex*, simple; not divided. 2. *bifidus*, bifid. 3. *trifidus*, trifid. 4. *bipartitus*, two-parted. *d.* In respect to its figure, the style is, 1. *teres*, columnar. 2. *cylindricus*, cylindrical. 3. *capillaris*, capillary. 4. *clavatus*, club-shaped. 5. *subulatus*, subulate. 6. *alatus*, winged. 7. *tetragonus*, four-cornered. 8. *ensiformis*, ensiform. 9. *pubescens*, pubescent; covered with pubescence. 10. *villosus*, villous. *e.* In respect to its direction, the style assumes most, if not all the directions which have been noticed in treating of the filaments. *f.* In respect to its situation, 1. the style, in the greater number of plants, is *in apice germinis*, placed on the top of the germ. 2. *ad latus germinis*, at the side of the germ: that is, the styles, which are numerous, proceed from within the side of their corresponding germs. This structure is observable in the Rose, the Raspberry, the Strawberry, the Cinquefoil, the Tormentil, and other plants belonging to the order *Polyginia*, in the twelfth class, or *Icosandria*, of the sexual system. *g.* In point of duration, the style is, 1. *persistens*, permanent; remaining until the fruit be ripe; as in the plants of the class *Tetradynamia*. 2. *deciduus*, deciduous; falling off with the other parts of the flower; as in the greater number of vegetables.

C. The Stigma is the third and last portion of the pistillum. It is the summit or top of this female part of the plant, and is destined to receive the influence of the pollen, and transmit it to the germ. In the Latin language, the word *stigma* has several significations, none of which are agreeable to the senses in which it is employed by L. I wonder, with Professor Martyn, why the Swede did not make use of the more classical and appropriate word, *fibula*.* Dr. Grew called the stigma, the knob, or button; and Dr. Withering the Summit. *a.* The number of the stigmas is very different in different vegetables. Some plants have only one stigma; some two, some three, some four, some five, &c. *b.* In respect to division, the stigma is, 1. *simplex*, simple. 2. *fissum*, cleft. 3. *bifidum*, two-cleft. 4. *trifidum*, three-cleft, &c. &c. 5. *partitum*, parted. 6. *bipartitum*, two-parted, &c. 7. *lobatum*, lobed. 8. *bilobum*, two-lobed, &c. &c. *c.* In respect to figure, the stigma is, 1. *capitatum*, capitate; approaching in its form, at the top, to the shape of a globe. 2. *globosum*, globular. 3. *urceolatum*, urceolate; pitcher-shaped. 4. *ovatum*, ovate. 5. *obtusum*, obtuse. 6. *truncatum*, truncated. 7. *oblique depressum*, obliquely depressed. 8. *emarginatum*, emarginate. 9. *planum*, flat. 10. *reniforme*, reniform. 11. *orbiculatum*, orbicular. 12. *peltatum*, peltate.† 13. *coroniforme*, crown-shaped. 14. *cruciforme*, cruciform; in the form of a cross. 15. *stellatum*, stellate. 16. *canaliculatum*, channelled. 17. *concavum*, concave. 18. *umbilicatum*, umbilicate; concave, and orbicular. 19. *plicatum*, plaited. 20. *radiatum*, radiate; marked with striated rays, which diverge from the centre. 21.

* *Fibula*, a button, a clasp, a buckle, &c. &c.

† See Plate I.

angulatum, angular. 22. *striatum*, striated. 23. *plumosum*, feathery. 24. *pubescens*, pubescent. 25. *filiforme*, filiform. 26. *capillare*, capillary. 27. *convolutum*, convolute. 28. *revolutum*, revolute. 29. *flexum sinistrorsum*, bent to the left. 30. *flexum dextrorsum*, bent to the right. 31. *barbatum*, bearded. 32. *imberbe*, beardless. *d.* In respect to measure, the stigma is, 1. *longitudine styli*, as long as the style, &c. *e.* In respect to expansion, the stigma is, 1. *fimbriato-crispum*, fimbriate-curled, or fringed. 2. *foliaceum*, foliaceous, or like a leaf. 3. *cucullatum*, cowled. *f.* In respect to its duration, the stigma is, 1. *persistens*, permanent; remaining until the fruit be mature; as in Sarracenia,* Podophyllum,† and others. 2. *marcescens*, shrivelling, remaining, but becoming withered; as in the greater number of plants.

The pistil, or female organ, consists of the germ, the style, and the stigma, is of no less consequence in the study of Botany than is a knowledge of the stamens. In a physiological point of view, each set of these sexual organs is entitled to an equal portion of our attention. They are equally concerned in the perpetuation of the species. The pollen of the anthers would have been secreted or formed in vain, were there no stigma or germen to receive and preserve its vivifick influence.

VI. The Pericarpium‡ is the fifth part of the fructification enumerated by L. He defines it "a viscus, or organ, gravid (big) with seeds (that is, a vessel producing seeds,) which it lets drop when they are ripe." "Viscus gravidum seminibus, quæ matura dimittit."§ He has also called it the "Ovarium fœcundatum,"|| or "impregnated germ or ovary." By the English botanists it is denominated the Pericarp, Seed-vessel, or Seed-case. Each of these terms may be employed; for each is just and significant. I shall, however, more generally make use of the word pericarp, as being most agreeable to the prevailing English botanical nomenclature which is adopted in these *Elements*. Dr. Johnson's definition of the word, in his *Dictionary*, is extremely lame, and exceptionable. He says the pericarp is "a pellicle or thin membrane encompassing the fruit or grain of a plant, or that part of a fruit that envelopes the seed." The pericarp is the developed germ, ovary, or seed-bud: that is, the germ fecundated, swollen, and arrived at maturity, after having received the influence of the pollen, or fecundating powder. L. has, therefore, very properly compared this part of the fructification to the fecundated ovary in animals. It is certain that, in general, the vegetable germ is not evolved into a *true* pericarp, if the pollen has been prevented from having access to the stigma. The pericarp is an organ of great importance. Hence, like all the truly im-

* See Plate I. † See Plate XVIII.

‡ From περι, around or about, and καρπος, fruit, or seed.

§ Philosophia Botanica, &c. p. 53, § 86.

|| Ibid. p. 92. § 146. "Pericarpium *Ovarium fœcundatum*, unde ova producit fœcunda."

portant parts of vegetables, and of animals, it is very generally present. Its use is obvious; to keep and preserve the seeds until they are ripe; to serve as "the guard of the seed,"* and then to commit them to the bosom of the earth, or to the air, and waters. Some plants are destitute of the pericarp. This is the case in the Asperifoliæ, or Rough-leaved plants, in the Verticillate plants, and in the Compound-flowers. In these families of vegetables, the place of the pericarp is supplied by the calyx, which encloses the seed, and accompanies them to perfection; or by the receptacle, of which I am afterwards to speak more particularly. I cannot pretend to state, in this place, the proportion of plants that are destitute of the pericarp, compared to those which are furnished with this viscus. It may, however, be proper to observe, that the compound flowers form a very extensive family in most countries, (particularly, perhaps, in North America;) and that many of the genera belonging to the other orders which I have mentioned, embrace a great number of species. L. enumerates eight different species of pericarp, viz. 1. the *Capsula*, 2. the *Siliqua*, 3. the *Legumen*, 4. the *Folliculus*, 5. the *Drupa*, 6. the *Pomum*, 7. the *Bacca*, and 8. the *Strobilus*.

1. The Capsula,† or first species of pericarp which I have mentioned, is called by the English botanists Capsule, little chest, or casket. It is a membranaceous, hollow pericarp, which spontaneously opens or splits, in some determinate manner, or differently in different vegetables: "Pericarpium cavum, determinate dehiscens."‡ Dr. Grew distinguishes all the dry-seed vessels; whether they be capsules (in the Linnæan sense of the word,) or pods, by the name of "seed-cases," or "membranous uteri," in opposition to the pericarps of a pulpy kind, such as the fruit of the Apple, the Quince, the Cherry, the Gooseberry, and others; these last he nominates fruits. This distinction of the great English philosophical naturalist, is more agreeable to the prevailing ideas with regard to all the various kinds of pericarp, than the distinction of L. and the botanists of his school. Nevertheless, the term pericarp, as a generic term, may, with great propriety, be employed. *a.* In respect to its figure and substance, the capsula is, 1. *turbinata*, turbinate. 2. *inflata*, inflated. 3. *globosa*, globular. 4. *didyma*, twin, or didymous. 5. *scrotiformis*, purse-like; elevated with two protuberances. 6. *cylindracea*, cylindrical. 7. *columnaris*, columnar; cylindrical and capitate. 8. *ovata*, ovate. 9. *subrotunda*, roundish. 10. *oblonga*, oblong. 11. *obcordata*, obcordate; inversely cordate. 12. *obtusa*, obtuse. 13. *acuminata*, acuminate. 14. *ventricosa*, ventricose; oblong and very convex. 15. *compressa*, compressed. 16. *membranacea*, membraneous. 17. *elastica*, elastic. 18. *triquetra*, triquetrous. 19. *tetragona*, four cornered.§ 20. *trisulca*, three-fur-

* Mr. John Ray.

† Capsula, in Latin, signifies a little coffer, or chest, or casket

‡ Philosophia Botanica, &c. p. 53. § 86.

§ See Plate X.

rowed. 21. *triloba*, three-lobed. 22. *quinquedendata*, five-toothed. 23. *coronata*, crowned; the extremity furnished with leaflets, digested into a crown. 24. *circumscissa*, cut round; or bursting all round, horizontally, like a snuff-box; as in Anagallis. 25. *articulata*, jointed; intercepted by joints. 26. *coriacea*, coriaceous; resembling leather; as in Æsculus.* ·27. *carnosa*, fleshy; resembling flesh; as in Pontederia. 28. *lignosa*, woody; of a woody texture; as in Cedrela. Capsules, in splitting or opening, are divided externally into one or more pieces, to which L. has given the name of *Valvæ* and *Valvulæ*,† or Valves. The valve is the outer coat, shell, or covering of a capsule, or any other species of pericarp, or the several pieces which compose it. It is rather the door, or opening, by which the seeds of the capsule are to go out, or escape. According to the number of its valves, the capsule is, 1. *bivalvis*, bivalve, or two-valved; splitting into two parts or pieces; as in Celandine, and in all the siliques and legumes. 2. *trivalvis*, trivalve, or three-valved; opening with three valves; as in Violet, Æsculus, Cistus Helianthemum, and others. 3. *quadrivalvis*, quadrivalve; or four-valved; opening with four valves; as in Ludvigia, Oenothera, &c. 4. *quinquevalvis*, quinquevalve, or five-valved; opening with five valves, as in Hottonia, Flax, Lime-tree, (Tilia,) Syrian-Mallow, (Hibiscus,) and Cotton (Gossypium.) The internal divisions of the capsule are denominated *Loculamenta*,‡ or Cells. These are the chambers appropriated for the reception of the seeds. According to the number of these cells, the capsule is, 1. *unilocularis*, unilocular, or one-celled; as in the Primrose. 2. *bilocularis*, bilocular, or two-celled; as in the Henbane, Tobacco, and Thorn-apple, or James-town-weed. 3. *trilocularis*, trilocular, or three-celled; as in the Lily, the Hyacinth, &c. 4. *multilocularis*, multilocular, or many-celled; as in the different kinds of Nymphæa and Nelumbium, which are known by the names of Water-Lily. The capsule has received different names, according to the number of the seeds which it contains. Thus, we have, 1. *capsula dicocca*, a dicoccous or two-grained capsule; consisting of two cohering grains or cells, with one seed in each. 2. *tricocca*, tricoccous or three-grained; swelling out in three protuberances, internally divided into three cells, with one seed in each; as in the genus Euphorbia, or Spurge. 3. *pentacocca*, pentacoccous, or five-grained; swelling out in five protuberances, or having five united cells, each containing one seed. The partitions by which the capsule is internally divided into cells, are called by L. *Dissepimenta;* each of these partitions, *dissepimentum:* "a wall separating a pericarp internally into cells." Dr. Martyn calls this part of the plant the partition: but I think it better to use the word Dissepiment. The dissepiment is either, 1. parallel, *dissepimentum*

* See Plate XV. D. E.

† From the Latin *valvæ*, doors or gates, which open and shut on both sides; folding-doors. L. does not make any distinction between valva and valvula.

‡ *Loculamentum*, in Latin, signifies a case, a drawer, a bag, &c.

parallelum, or, 2. contrary.* The former approaches in breadth and its transverse diameter to the valves; as in Lunaria and Draba. The latter is narrower than the valves; or, as L. more fully expresses it in the *Delineatio Plantæ*, narrower, when the valves, by being squeezed or contracted, become concave. ("Angustius ubi valvulæ coarctatæ evadunt concavæ.") This is exemplified in Biscutella and Thlaspi. L. borrowed these two terms from Tournefort: he observes, that they are to be understood with some allowance as to the manner in which they are employed. This is candidly observed. "I should have conceived, (says Dr. Martyn,) a parallel partition in a siliqua or pod to have been in the direction of the valves—a contrary or transverse one, at right angles with the valves." By some English writers on Botany, the name of transverse dissepiment is given to the dissepiment called by L. contrary. The *Columella*,† is the central pillar in a capsule. It is the part which connects the several internal partitions with the seed: "Pars connectens parietes internos cum seminibus."‡ It takes its rise from the receptacle, and has the seed fixed to it all round.

For Representations of different kinds of capsules see Plates IV, VIII, X, XI, XII, XIV, XV, &c. &c.

2. The Siliqua, Silique, or Pod, is a two-valved pericarp, having the seed fixed along both sutures. The proper silique is bilocular, or two-celled, being furnished with a partition which runs the whole length of this kind of pericarp. It is to be observed, however, that some pericarps which have the same form, take the name of siliqua, although they have no partition, and, of course, are unilocular, or one-celled; as in Fumitory (Fumaria,) and Celandine, or Cheledonium.

L., after Ray, has distinguished the silique into the siliqua, properly so called, and the *silicula*, or silicle. These two pericarps do not essentially differ from each other: they differ only in form and size. The first-mentioned species is much longer than it is broad: we have examples of this kind of pericarp in the following vegetables, viz. Mustard, Radish, Wall-flower (Cheiranthus,) Water-cresses, Bignonia longissima, and many others. The silicle is almost round, or at least makes a much nearer approach to the obicular form; as in the Lunaria (called Honesty and Satin-flower,) in Alyssum (Mad-wort,) Thlaspi (Shepherd's Purse,) Iberis (Candy-tuft,) and others. This difference in the form and shape of the silique and silicle, is assumed by L. as the foundation of the two orders into which he has distributed the plants of the fifteenth class of his system.

a. In regard to its figure, the species of pericarp of which I have been speaking (whether silique or silicle) is, 1. *compressa*, compressed. 2. *torosa*, torose; swelling out into knobs, like the veins and muscles.

* *Dissepimentum contrarium.*

† *Columella*, in Latin, signifies a little pillar, a tomb-stone, or pillar of inscription.

‡ Philosophia Botanica, &c. p. 53, § 86.

3. *torulosa*, swelling as above, but in a smaller degree. 4. *articulata*, jointed; intercepted with tight joints.* 3. The Legumen, or Legume, is a pericarp of two valves, in which the seeds are fixed along one of the sutures only. By this circumstance, it differs from the last mentioned species of pericarp, in which we have seen the seeds are fixed to both sutures. The old English word for the legume was cod,† and the pericarp of the Pea: which is a true legume, is still called a Peas-cod. "Pod (as Dr. Martyn observes) is used both for the legume and the silique indifferently: but they are so distinct, that they ought not to have the same appellation. It seems better, therefore (the same ingenious writer remarks,) to anglicize the Latin terms: and with respect to this, it is become sufficiently familiar to the English ear."‡ In the United States, it may, however, be observed, that the word cod is much less generally applied to the legume, or any other species of pericarp. *a.* In regard to its figure, its substance, &c. the legume is, 1. *subrotundum*, roundish. 2. *ovatum*, ovate. 3. *oblongum*, oblong. 4. *lineare*, linear. 5 *rhombeum*, rhombed, or rhomb-shaped. 6. *rhomboidale*, rhomboidal; of a rhomboid form. 7. *lunulatum*, crescent-shaped. 8. *muticum*, awnless; without a point. 9. *obtusum*, obtuse. 10. *acuminatum*, acuminate. 11. *spina mucronatum*, mucronate with a thorn. 12. *venosoreticulatum*, venose-reticulated; the veins disposed so as to form a net-work. 13. *venosc-varicosum*, venoso-varicose; the veins dilated so as to form varices. 14. *striatum*, striated. 15. *villosum*, villose. 16. *tuberculatum*, tubercled; covered with cartilaginous points. 17. *scabrum* rough. 18. *planum*, flat. 19. *membranaceum*, membranous. 20. *foliaceum*, foliaceous. 21. *diaphanum*, diaphanous. 22. *coriaceum*, coriaceous. 23. *gibbum*, gibbous. 24. *teres*, columnar. 25. *teretiusculum*, somewhat columnar. 26. *cylindraceum*, cylindrical. 27. *alatum*, winged. 28. *angulis membranaceis*, with membranous angles. 29. *compressum*, compressed; as in Gleditsia triacanthos, called Honey-Locust. 30. *nodosum*, knotty; elevated in knots. 31. *inflatum*, inflated. 32. *turgidum*, turgid; swollen, as in Ononis, and Crotallaria sagittalis (called in the United States, Rattle, and Rattle-Box.) N. B. The turgid and the inflated legume are thought, by some writers, to be no ways different: "but in the latter" as Dr. Martyn observes "I apprehend the pericarp to be in substance, as well as in form, somewhat like a blown bladder; whereas in the former it is merely more swelled out, and has a wider cavity than usual." We have a good example of the *legumen inflatum* in Colutea, or Bladder-Senna. 33. *torosum*,

* See Plate XXVI.

† Thus May, in the following lines:

"Thy corn thou there may'st safely sow,
"Where in full *cods* last year rich pease did grow."

‡ The Language of Botany, &c.

torose, or necklace-form; gibbous, with protuberances disposed linearly. 34. *farctum*, stuffed; full of a pulpy or fleshy substance. 35. *pulposum*, pulpy; filled with pulp. 36. *carnosum*, fleshy; filled with a fleshy substance. 37. *lignosum*, woody. 38. *subulatum*, subulate. 39. *falcatum*, falcate, or sickle-shaped; compressed, subulate, and curved. 40. *sessile*, sessile. 41. *pedicellatum*, pedicelled; elevated on a pedicel. 42. *rectum*, straight; without a bend. 43. *strictum*, stiff and straight. 44. *rigidum*, rigid. 45. *ascendens*, ascending, with an ascending point. 46. *incurvatum*, incurved. 47. *arcuatum*, bowed; bent like a bow. 48. *inflexum*, inflected. 49. *reflexum*, reflected. 50. *revolutum*, revolute.

b. In regard to its measure, the legume is, 1. *longissimum*, very long, with respect to the corolla. 2. *longum*, long. 3. *maximum*, very large, as in Gleditsia. 4. *minimum*, very small; as in the different kinds of Clover (Trifolium.) 4. *latissimum*, very broad. *c.* In regard to its structure, the legume is, 1. *articulatum*, jointed. 2. *uniloculare*, unilocular. 3. *biloculare*, bilocular. 4. *isthmis interceptum*, divided transversely, within, into different cells. Plants that are furnished with the legume, as a pericarp, are known by the name of *Leguminosæ*, or Leguminous Plants. The greater number of these vegetables are arranged by L. under his seventeenth class, or Diadelphia. It may here be observed, that Dr. Arbuthnot and some other English writers, have confounded the siliquose and leguminous plants with each other. Dr. Johnson does not seem to have had correct ideas on the subject.* This, however, is the more excusable, since the ancients themselves, as L. observes, confounded under one name the pericarps of the Tetradynamous and Diadelphous plants: that is, the silique and legume. Thus, Columella denominates the pods of Beans, "siliquæ." Virgil uses *siliqua* in the same sense.†

We are certain, from a passage in Pliny, that Virgil is speaking of Beans, and of course, that the word siliquis is properly translated by pod. But the word *legumen* very frequently occurs in the writings of the Roman authors. In these it seems to imply every species of pulse, such as Beans, Pease, &c.

Even L. himself has sometimes confounded the terms siliqua and legumen. Thus in his *Prælectiones in Ordines Naturales Plantarum*, he calls the pericarp of the *Lomentaceæ* a "siliqua:" but at a subsequent period he denominated it a *legumen*. For representations of the Legume, see Plate XXI.

4. The Folliculus,‡ or Follicle, is a one-valved pericarp, which opens longitudinally only on one side, and having its seeds loose within it, that is not bound to the suture. In the writings of L., the terms fol-

* See his Dictionary.

† Georgic. lib. I. l. 193—195.

‡ *Folliculus*, in Latin, signifies a little leather bag, a husk of wheat, or other grain.

liculus and conceptaculum (conceptacle,) are entirely synonymous. The latter term occurs in the *Philosophia Botanica,* the former in the *Delineatio Plantæ,* and in the early and late editions of the *Genera Plantarum.* We have examples of this species of pericarp in the genera Nerium, Stapelia, Cynanchum, Periploca, Apocynum, Asclepias, Embothrium, and others.

5. The Drupa, or Drupe, is a species of pericarp which is destitute of valves, and contains a nut or stone, within which there is a kernel. The drupe is mostly a moist and succulent fruit, as in the Plum, the Cherry, the Apricot, the Peach, and the Olive: but sometimes it is dry, as in the Almond. To these two species of drupa have been given the names of 1. *succulenta,* succulent, or juicy; containing a fluid, and 2. *sicca,* dry, or juiceless; opposed to the preceding term.

The term drupa is sanctioned by classical authority. It is employed by Pliny, who uses the word for the fruit of the Olive.* The term is synonymous to Tournefort's "fructus mollis ossiculo," or, soft fruit with a stone. It is also equivalent to the term Prunus, as employed by other botanists. The nut, or stone, which in the drupe is surrounded by the soft, pulpy flesh, is a kind of woody cup, which commonly contains a single kernel, called *Nucleus.* The hard shell thus enveloping the kernel is denominated *Putamen.* As L. is not always consistent, so the reader will not be surprised to fine that the definition which has just been given of the drupe does not apply to every pericarp designated by this name in the *Genera Plantarum.* For not again to mention the Almond, L. calls the pericarp of the Elm (Ulmus) a drupe, although its substance is like parchment, and its seed are not contained within a stone. Beside the vegetables which I have mentioned, the following indigenous plants furnish good examples of the drupe, viz. the Sour-Gum and Sour-Olive of the United States, (Nyssa integrifolia and N. denticulata;) different species of Laurus, such as Sassafras (Laurus Sassafras,) Spice-wood (Laurus Benzoin,) and others. The term drupe gave name to an order, *Drupaceæ,* in the former editions of L.'s *Fragments of a natural method.* This order (the thirty-eight,) comprehended the Almond, the Peach, the Plumb, the Apricot, the Cherry, and the Bird-seed: but they were afterwards referred to the order *Pomaceæ,* some account of which is given in the last part of this work.† 6. The Pomum, or Pome,‡ or Apple,§ is a pulpy pericarp, without valves, but containing a membranous capsule,‖ with a number of cells or cavities, for the lodgment of the seeds. This species of pericarp has no external opening or valve. At the end opposite to the peduncle, or footstalk supporting the pome, there is frequently a small cavity, to which the gardeners have given the name of the eye of the fruit. The Apple, the Pear, the Quince, the Gourd, the Cucumber, the Melon, and many

* Lib. XV. cap. vii.

† See Class XII. ICOSANDRIA.

‡ Dr. Martyn.

§ Dr. I. E. Smith.

‖ "Pericarpium farctum evalve, *Capsulam* continens."

others, furnish us with instances of this species of pericarp. Several of these plants belong to L.'s order Pomaceæ, just mentioned. *a.* In regard to its figure, the pomum is, 1. *oblongum*, oblong. 2. *ovatum*, ovate. 3. *globosum*, globular. 4. *subrotundum*, roundish; not to mention many other forms; for the form of fruits is immensely varied by climate and by soil. *b.* With respect to its cells, this species of pericarp is *triloculare*; three-celled, &c.

7. The Bacca, or Berry, is a succulent or pulpy pericarp, without valves, and containing naked seeds, or seeds which have no other covering. The seeds, in this species of pericarp, are sometimes dispersed promiscuously through the pulpy substance, as in the Water-Lily: but they are more generally placed upon receptacles, or footstalks, within the pulp; as in the Currant, the Gooseberry, the Raspberry, the Hydrastis, called in the United States, Yellow-root, and many others. To the former kind of seed L. has given the name of *semina nidulantia*, or nestling seed. *a.* The berry assumes a considerable variety of forms. It is, however, very frequently round, or oval, and is often furnished with an *umbilicus*, or small cavity, at the end opposite to the footstalk, as is the case in the Apple, and other species of the Pomum. This species of berry is called by L. *bacca umbilicata*. *b.* According to the number of seeds which it contains, the bacca is, 1. *monosperma*; one-seeded; containing a single seed; as in Plinia, &c. 2. *disperma*, two-seeded; containing two seeds; as in Chiococca. 3. *polysperma*, many seeded. containing several seeds; as in the Persimmon, (Diospyros virginiana,) Witheringia, May-apple (Podophyllum peltatum,) and others. In the use of the term bacca, or berry, L. is sometimes as inconsistent as in the use of the term drupe. Thus, he calls the pericarp of Lesser-Burdock, (Xanthium,) a berry: but it is dry, and contains within it a nut, which is furnished with two cells! Again, he calls the pericarp of Capsicum, a berry. But this has no pulp, and is hollow within. The following pericarps, though certainly very different from each other, are all denominated by L. berries, viz. Sumach (Rhus,) Nightshade (Solanum,) Sow-bread (Cyclamen,) Medlar (Mespilus,) Orange and Lemon (Citrus Aurantium and C. medica,) Yew (Taxus,) and Pine-apple, or Bromelia. *c.* The berry is said to be proper, or improper. The former is formed of the pericarp, or seed-vessel. The latter is formed of any of the other parts of the fructification. Thus, in the Mulberry, the Rose, the Blite (Blitum,) and Myrtle-leaved Sumach (Rhus Coriaria,) the large, fleshy, and succulent calyx becomes a berry. In the Strawberry and Cashew-nut (Anacardium,) it is formed from the receptacle: in the Raspberry and Adonis, of a seed: in the Marvel of Peru (Mirabilis) of the nectary: in the Garden Burnet (Poterium-Sanguisorba) of the tube of the corolla, which hardens and shuts, for the purpose. Certain fruits, such as Mulberry, Raspberry, Blackberry, not to mention many others, which are generally regarded as berries, have, with more propriety, been denominated Compound and Spurious Berries: for in these, each of the component parts, which are called *acini*, or

granules, may, very properly, be considered as a distinct berry, containing a single seed, immersed in the pulpy matter. The berry does not spontaneously gap or burst, as do the four first species of pericarp which I have mentioned, viz. the capsule, the silique and silicle, the legume, and the follicle, or conceptacle. Birds and other species of animals, as we shall afterwards see, are very instrumental in the dissemination or dispersion of various kinds of berries. "Finis Baccæ," says L., "ut semina ab animalibus serantur: e. gr. *Viscum*."* For representations of different kinds of berry, see, in this work, Plates I, IX, XIV, XVIII.

8. The Strobilus,† or Strobile, is the last species of pericarp enumerated by L. He defines it, a pericarp formed from an ament, by the induration of the scales. This is the definition as given in the *Termini Botanici.* In the *Delineatio Plantæ*, it is thus expressed, "Strobilus imbricatus amenti coarctati." That is, the strobile is made up of scales that are imbricate, or lie over each other, from an ament contracted or squeezed together, in this state of maturity." "This term includes (as Dr. Martyn observes,) not only the cone of former writers, but also some other fruits, which recede considerably in structure from that sort of pericarp; as that of Magnolia," Tulip-tree (Liriodendron,) and others. It must be evident, therefore, that it is improper to translate strobilus by cone, as has been done by some writers. The strobile assumes a variety of forms in different vegetables.

Although L., in the later editions of his works, has discarded the term cone, and adopted that of strobile, he has, nevertheless, retained an order of vegetables, which he calls *Coniferæ*, or Cone-bearing of which notice will be taken in a subsequent part of the work. To this order belong the Fir, the Pine, the Cypress, the Thuja, and others. Beside the eight species of pericarp above mentioned, four other species are enumerated by Professor Scopoli, of Pavia. These are the *Theca*, the *Granatum*, the *Cysta*, and the *Scrinum*. Of each of these it is proper that I should take some notice. 9. The Theca‡ is defined to be a double involucre of the seed, the exterior covering bursting open; the interior one, which is either pulpy, membranaceous, hairy, or woolly or brittle, involving the seed. "Fructus cum involucro duplici; exterius, dehiscens, interius, pulposum, membranaceum, pilosum, lanatum aut fragile, semina obvolvens."§ We have examples of this species of pericarp in the Euonymus, or Spindle-tree, and in the Celastrus, or the Staff-tree, and several others. L. was not unacquainted with this species of pericarp. He did not, however, consider it as a pericarp, but as the proper

* Philosophia Botanica, &c. p. 75. § 113.

† Strobilus has very different significations in the Latin language; it signifies a wild Pine-tree, a Pine-apple, an Artichoke, and also a whirlwind.

‡ Theca, in Latin, signifies a sheath or case, also a box or bag, and the husk of corn.

§ Necker. See his *Corollarium*, &c. p. 28.

and exterior coat or covering of the seed,* which falls off spontaneously, or encloses the seed partially. I think, however, that the theca may very properly be considered as a species of pericarp. In this opinion, I follow not only the learned Scopoli himself, but also Giseke, and some other writers. By some English botanists the theca has been denominated the Case. 10. The Granatum,† or Granate, is also a double involucre; one of the covers being of a corky or coriaceous texture, the other succulent. In this species of pericarp, however, of which we have the most familiar instance in the Punica Granatum, or Pomegranate, neither of the involucres, or covers, splits or opens. 11. The Cysta,‡ or Cyst, consists of three covers, one of which is membranaceous, another succulent or fleshy, and the third, and most interior, also membranaceous or brittle. Neither of these covers splits or opens. "Cysta, fructus minime dehiscens e germine oriens, triplici involucro. Exterius, membranaceum, fragileve semina involvens." The Berberis, or Barberry, supplies an example of this species of pericarp. 12. The Scrinum,§ or Scrine, is also composed of three covers, viz. an exterior one, which is of a woody texture, and does not split at all; a middle one, which is pulpy, and an interior one, which is membranaceous, envelopes the seed, and spontaneously splits or opens: "Fructus ex involucro triplici compositum. Exterius, lignosum minime dehiscens, medium pulposum, interius sponte dehiscens, membranaceum, semina fovens."||

I do not know that names for all of these four species of pericarp have been as yet introduced into the English botanical nomenclature. I think we may use the following, viz. Theca (without any alteration,) the Granate (sufficiently distinct from the compound stone called granite,) the Cyst, and the Scrine.

VII. The Semen, or Seed, is the sixth part, and the "end and aim," of the fructification. It is defined by L. the deciduous part of a vegetable, containing the rudiments of a new or other vegetable of the same species, and fertilized by the aspersion or sprinkling of the pollen, or fecundating powder: "pars vegetabilis decidua, novi rudimentum, Pollinis irrigatione vivificatum."¶ The parts of a seed, properly so called, are enumerated by the Swedish naturalist, as follows: viz. 1. the *Corculum.* 2. the *Cotyledon.* 3. the *Hilum.* 4. the *Arillus.* 5. the *Coronula*, and 6. the *Ala.* Of each of these parts I shall give some ac-

* Arillus.

† Granatum is used by Pliny (Lib. XX. cap. xiv.) as the name of the Punica Granatum, or Pomegranate-tree.

‡ Cysta, or rather Cista, signifies, in Latin, a basket, or chest for books, money, &c.

§ Scrinum, or scrinium, signifies a casket or coffer, an escretoire, a bookcase, &c.

|| Necker. Corollarium, &c. p. 17, 18.

¶ Philosophia Botanica, &c. p. 54. § 86.

count, though not in the precise order in which I have mentioned them. I shall also take notice of some other parts of the seed, unnoticed by L.; for since his time the subject has excited much more attention than he has devoted to it. A. The Hilum.* This part, which is frequently called the Eye, is an external cicatrix, mark or scar, of the umbilical chord of some seeds, where they adhere to the pericarp. In other words, it is the scar formed by the breaking off or separation of the stalk to which it was affixed, and by which it receives its nourishment, whilst in the pericarp or vegetable womb. In the *Delineatio Plantæ*, L. denominates the hilum, "cicatrix umbilicalis," and, in his *Philosophia Botanica* he thus defines it: "Cicatrix externa seminis ab ejusdem affixione in fructu." This part of the seed is more or less conspicuous in different seeds. In the following, it is very large and conspicuous, viz. the Garden-Bean† (Vicia Faba), in the Cardiospermum, or Heart-seed; and in the Staphylea trifolia, or Bladder-nut.

B. Besides the hilum, we observe, in various species of seeds, particularly when in their green state, a very minute foramen, or hole, of which I think L. has taken no notice. This aperture is perceptible, even without the assistance of a glass, in the full-grown Garden-Bean. In this species of seed, it is situated at the end of the hilum, and immediately at the point of the radicle, which is presently to be mentioned.‡ It is uncertain whether this foramen be present in all seeds. Some writers§ have supposed, that it is. Possibly, it is constant in all seeds. We cannot doubt that it exists in many in which neither the armed or unarmed eye has detected it. It is so minute, that it may readily escape our notice, especially in small seeds, when they are perfectly ripe and dry.

The use of this foramen is unknown to us. Dr. Grew, who was acquainted with it, supposed, that the moisture, which the Bean absorbs, when it is committed to the earth, and by which it becomes distended, finds a passage through this aperture The late Mr. Curtis made an experiment to ascertain the truth of this opinion. He covered the aperture in six Peas (Pisum sativum,) with a strong spirit varnish, and placed them in a pot of moist earth, along with six other Pease, which were of the same weight. The following day, he took them out of the pot, and upon weighing them, he found, that the varnished were nearly as heavy as the unvarnished seed, and that there was but little difference in the size of the Pease thus treated. From this experiment, the ingenious experimenter concludes, "that the moisture which the Pea absorbs, enters the Cotyledons by some other channel than the aperture, most probably the whole surface of the husk is permeable."‖

* The word hilum, in the Latin language, signifies the little black of a Bean, and, also, a very nothing. In this sense it is used by Cicero and by Lucretius.

† See Plate v. Fig. A. 1. Fig. D. 1.

‡ See Plate v. Fig. A. 4.

§ Mr. Curtis. ‖ A Companion to the Botanical Magazine, &c. p. 6.

I think it probable, that the whole surface of the husk is really permeable: but it must be observed, that Mr. Curtis's experiment is not conclusive. His Pease were not left for a sufficient time in the earth, and it does appear, that the seed in which the foramina were not varnished had absorbed, in the course of about one day, *more* moisture than the others.

C. By the Arillus, Aril,* or Tunic,† L., as I have already observed, means a particular covering of the seed, to which other writers have given the name of pericarp. I shall not employ arillus, in the L. sense of the word, but shall speak of the coverings of the seed under othe names.

By some writers,‡ the exterior covering of the seed is denominated the *Cutis*, or Husk. Gærtner,§ who has devoted more attention to the seed than any other writer, divides the Proper integuments of seeds *(Integumenta seminum propria,)* into the *Testa*, or Shell, and the *Membrana interna*, or Internal Membrane. These are the coats which invest the nucleus (kernel;) they do not separate, except under germination, and even then, not spontaneously: they are burst irregularly by the swelling of the cotyledons. 1. When the seed is furnished with two proper coats, the shell is the outer one: when there is only one coat, this is accounted the shell; and when there are more than two coverings, the second from the nucleus is named the shell. The shell is deemed an essential part of the seed, because the kernel, which originally was wholly fluid, could not have been formed unless a coat had been placed round it. This integument is never wanting. *a.* In regard to its consistence, &c. the testa is, 1. *membranacea*, membranous. 2. *pellucida*, pellucid; as in Rice (Oryza.) 3. *opaca*, opaque; dry and almost friable; as in Messerchmidia. 4. *chartacea*, paper-like, and somewhat elastic and very tough; as in the Indian-corn (Zea Mays.) 5. *coriacea*, coriaceous; thicker than the preceding. 6. *spongiosa*, *fungosa*, and *suberosa*, spongy, fungous, or cork-like; formed of a porous substance. 7. *carnosa*, fleshy. 8. *crustacea*, crustaceous; thin, and not capable of being softened by water, or cut by a knife, but easily broken by the fingers; as in the Palms. 9. *ossea* and *lapidea*, differing from the preceding, only in thickness and hardness. *b.* The testa is, 1. *bilocularis*, or two-celled; as in Sapindus. 2. Most generally, however, it is *unilocularis*, unilocular, or one-celled, containing a single kernel. 2. The internal membrane is generally present, but is, nevertheless, often wanting. This integument always closely invests the kernel, but readily secedes from the shell. It is, 1. *membranacea*, or membranous; or, 2. *subpongiosa*, somewhat spongy. The former is the most common. The Chalaza is situated in the internal membrane. This is

* Dr. Martyn. †Dr. I. E. Smith. ‡ Curits, &c.

§ See his great and classical work, De Fructibus and Seminibus Plantarum, Stutgardiæ: 1783, & Tubingæ: 1791.

a part of the seed of which the learned Gærtner has taken particular notice. It is a small deep-coloured areola, or a small spongy or callous tubercle on the outer surface of the internal membrane of the seed; it is found in many but not in all seeds, and is either placed near the external umbilicus, or diametrically opposite to it. The latter situation is the most common. 3. The Accidental integuments, as Gærtner calls them, are superadded to the testa, or shell, of the seed, and either wholly or partially cover it in such a manner, that they may be easily removed. The first of these accidental coverings is called by Gærtner, the *epidermis*, or cuticle. It is a thin pellicle, which invests the whole seed, and never spontaneously separates from it. The epidermis is, 1. *membranacea*, membranous. 2. *mucilaginosa*, mucilaginous. This is only observed, when seeds, by being thrown into water, have their surface softened and resolved into a jelly, or mucilage. This is very observable in the seed of the Quince (Pyrus Cydonia,) and in those of the Siliquose plants. Gærtner retains the term *arillus*, or aril, as one of the accidental integuments, which covers the seed, either wholly or partially, adhering only to the navel. Of the aril, I have already spoken under the head of pericarp, and have nothing further to say concerning it, in this place. D. The *Nucleus*, or Kernel, is the part which fills the internal cavity of the various integuments which have been mentioned. It is of an almond-fleshy substance,* and generally composed of four distinct parts, viz. 1. the *Albumen*. 2. the *Vitellus*. 3. the *Cotyledon*; and, 4. the *Embryo*. Of these I shall treat in the order in which I have mentioned them. 1. The Albumen, or White of the Seed, is that part of the kernel which invests the cotyledons, and is thought to afford the same support to the germinating embryo, that the white of the egg does to the chick. Both in respect to its consistence and colour, the albumen, in many seeds, greatly resembles the white of a boiled egg. It is not deemed an essential part of the seed. It is wanting in many seeds, but, upon the whole, appears to be present in a majority of the many seeds which were examined, with a truly scientific patience, by Gærtner. It is present in the plants of the following natural orders, viz. the Grasses, the Palms, the Liliaceous plants, the Umbelliferæ, the Coniferæ, and the Multisiliquæ, not to mention some others. The albumen is wanting in the seeds of the Compositæ, the Verticillatæ, the Siliquosæ, the Cucurbitaceæ, and the Asperifoliæ. In the Leguminous plants, a very great number of the genera are destitute of albumen, whilst a few are supplied with it. Among the plants of the class Monadelphia, there is a greater number of genera with albuminous than with exalbuminous seeds. Although the albumen is thus wanting in many seeds, it must be admitted, when present, to be a substance of considerable importance. It supports and defends the embryo, whilst this essential part

* That is retaining the impression of the nail. Gærtner calls it *amygdalinocarnosum*.

is imprisoned in the seed, and serves for the first nutriment of the embryo, when it begins to germinate. It has no connection with the embryo, whether it surround, or is surrounded by, the embryo: it is always so distinct; as to be very readily detached from it. The part of the kernel of which I am speaking, was not unknown to Dr. Grew, who gave it the name which it now retains. Gleichen calls it the "seminal placenta," whilst Meese and Boehmer designate it by the name of *cotyledon.* L. asserted, that the vegetable egg is destitute of albuminous matter, and that it is of no use in the seed. He would have said, with more truth, as Gærtner observes, that albumen is not found in all seed. Moreover, some seeds have but a very small quantity of this substance.

2. The Vitellus, or Yolk, is placed between the embryo and the albumen, and is different both from the cotyledons and the albumen. It is so closely connected with the embryo that it cannot be detached from it without injuring the substance of the latter. It is never carried without the shell of the seed, whilst this is germinating, nor does it become a seminal leaf, as the cotyledons do, but is entirely exhausted by the seminal plant and converted into its nourishment; in both which respects it resembles the albumen. In albuminous seeds, or seeds furnished with albumen, the vitellus occupies the middle place between it and the embryo, in such a manner that it can be easily separated from the albumen, without any injury to its form. It is evident, therefore that it has some affinity with the cotyledons, and also with the albumen. Of all the internal parts of the seed, the vitellus is the most uncommon. In the seeds of what are commonly called the more imperfect plants, such as the Fuci, the Mosses, and the Ferns, the vitellus presents itself in its most simple form and fabric. In these plants the whole kernel is a pure vitellus, which is formed of mere herbaceous or Almond-flesh, and exactly adapted to the cavity of its shell. Even here, although the *diagnosis* of it is difficult, it cannot, in the opinion of Gærtner, be referred to the albumen, because it does not contain within itself a distinct embryo, but is perfectly solid. Moreover, near the umbilicus of the seed, the vitellus has growing to it a "germinating cicatricle," which is not separable from the remaining substance of the kernel, nor even distinguishable from it, except by its paler colour, and more medullary consistence; as we observe in the seeds of Lycopodium. Nor can the substance in question be considered as a solid cotyledon, because in the germinating seeds of the Mosses, we plainly observe cotyledonous leaflets, arising below it from the seed; and it is seen adhering to these new and true cotyledons, a long time after their appearance, and the seminal plant consuming and destroying it. The vitellus, from all these circumstances, appears to be of an intermediate nature, between the albuminous and cotyledonous matter. In other vegetables, as in Ruppia and Zamia, the fabric of the vitellus is more evident. In the first of these plants it is very like to a fleshy albumen, and in Zamia, it is still more like albuminous matter. In Zostera, Ceratophyllum, and others,

the vitellus approaches nearer to the form of a true cotyledon, being formed of a white almond flesh, and divided into two lobes. In Ceratophyllum and Nelumbo, indeed, there is but little perceptible difference between the vitellus and the cotyledons. Upon the whole, however, the vitellus, in the opinion of Gærtner, constitutes a distinct kind of viscus.* 3. As the texture of the albumen is much more simple than that of the vitellus, so the fabric of this last mentioned part is less perfect than that of the cotyledons, which now claims our attention. The cotyledons† are organized parts of the kernel, simple or divided, which together with the radicle and plumule form the body of the embryo, which is next to be treated of, and by the germination of the seed, are commonly converted into the first leaflets of the new plant, which, in general, are different from the succeeding leaves. This is the definition of Gærtner. L. defines them to be the lateral body of the seed, bibulous or imbibing moisture, and caducous, or falling off quickly: "corpus laterale seminis, bibulum, caducum."‡ Professor Giseke defines it "folium primum germinantis seminis:"§ the first leaf of the germinating seed. But this is rather a definition of the seed-leaf. In English, the part of which I am speaking is commonly called the Seed-Lobe, "when we speak of it as a portion of the seed, in a quiescent state—and the seed-leaf, when the seed is in a growing state."|| From different writers the cotyledons have received different names. Jungius, in the seventeenth century, denominated them *Valvæ seminis*, or Valves of the seed. Gleichen called them *Lobi seminales*, or Seed-lobes: whilst by others they have been called *Foliola seminlia*, or Seminal-leaflets. L. adopted the name of cotyledon, which is used by Gærtner, and most of the other modern writers on botany; and which, indeed, seems preferable to any of the other appellations. In English, we shall avoid all ambiguity by employing the Latin word cotyledon, only using, in the plural, cotyledons. The cotyledons seem to derive their original from the embryo, of which they always constitute an integral part. In particular, the simple or undivided cotyledons are supposed to be formed by the mere extension of the corcle,¶ or first medullary point of the seed, and are nothing else than the scape of the embryo more or less distinct from its radicle; as in the Palms, the Grasses, and the Lilliaceous plants. On the other hand, however, the double

* In describing the different parts of the seed, such as the albumen, the vitellus, &c., I frequently employ, with but little alteration, the words of Gærtner, in his extensive history of these parts. Candour requires me to make this acknowledgment; and, whilst I make it, I must not omit to refer the reader, who is is anxious for more minute information concerning the history of the seed, to the learned and ingenious work of the German botanist.

† From κοτυλη, a cavity.

‡ Philosophia Botanica, &c. p. 54. § 86.

§ Termini Botanici.

|| Professor Martyn.

¶ See what is afterwards said on the Embryo.

or conjugate cotyledons are formed by the fissures, which divide the part of the corcle, opposite to the radicle, into two lobules, which are generally equal. *a*. In regard to its fabric, the cotyledon is generally composed of three distinct parts, viz. epidermis, or cuticle, parenchyma, and tracheæ, or vessels. 1. The cuticle invests the whole surface of the cotyledons, and, in the opinion of Gærtner, serves them partly as a filtre, through which the liquor of the amnion passes, and partly hinders them from coalescing with the neighbouring bodies. 2. The parenchyma proceeds from the internal bark of the embryo, and is formed of cellular texture, in the interstices of which are deposited a thick oil, and other inspissated liquors. This parenchyma alone forms nearly the whole mass of the cotyledons, and is commonly of an herbaceous, almond, or somewhat coriaceous consistence, and principally serves the purpose of depurating and containing the nutritious juices. 3. The tracheæ, or vessels, are dispersed through the whole cellular texture of the cotyledons, and connect them intimately with the contained embryo.* They seem to arise from the fleshy substance of the embryo, immediately below the origin of the plumule, and terminate with their fine extremities in the parenchyma, or the surface of the cotyledons. It is supposed† that they are of use to the seminal plant by performing the two-fold office of exhaling and absorbing vessels. Whatever may be their precise use, it is probable that they perform for the seed an office similar to that which is performed by the apparently same system of vessels, which are so conspicuous in the leaves and other parts of vegetables. The tracheæ are at all times conspicuous in the thinner cotyledons; and in the thicker ones they are rendered obvious to the senses by germination, and different coloured fluids, which they greedily absorb. We cannot doubt that this absorption depends upon a living principle (irritability,) inherent in the vessels of which I am speaking: for the absorption or propulsion of fluids is observed to be considerably increased by the application of various stimulating agents, such as camphor, nitre, &c. *b*. The number of the cotyledons is different in different seeds; upon the whole, however, the number of these parts is more constant than that of any other part of the fructification. Hence, as we shall afterwards see, some eminent botanists have founded their methods of vegetables principally upon the number of the cotyledons.

A seed, in the language of the botanists, is, 1. *Acotyledonous*. 2. *Monocotyledoncus*. 3. *Dicotyledonous*. or, 4. *Polycotyledonous*.

1. The seeds which are destitute of cotyledons are named Acotyledonous seeds, and the plants which arise from such seeds, Acotyledonous plants. The acotyledonous seed has no conspicuous or distinct embryo, but contains within itself only a *punctum saliens*, or mere germinating cicatricle ; or a certain simple *primordium* of a radicle, implanted in the kernel, and which is several times larger than itself;

* See Plate V. Fig. F.

† By Gærtner and others.

as in Ruppia, Zostera, Zamia, the Fuci, the Mosses, the Ferns, and the Fungous plants. A plant is named acotyledonous, which, without any preceding vestige of a true leaflet, arises from the earth, a frond of different species, but perfectly similar to the parent plant. Plants of this kind are seldom propagated from seed, but more commonly spring from simple or fruit like *(carpomorphi*)*, buds, as is the case with respect to the Fungous plants, the Lichens, the Confervae, and some of the Algae†. L.‡ Adanson, Jussieu, Gærtner, and other able botanists, have no hesitation in asserting, that there are seeds, which are acotyledonous, or destitute of cotyledons. On the other hand, however, Dr. Hedwig, of Leipsic, of whom it has been said, that he was "born to abolish Cryptogamy," asserts, that there are no seeds whatever destitute of cotyledons; that the powder of the Mosses (a tribe of plants which the botanists, whom I have mentioned, arrange under the head of *Acotyledones*) is the genuine seed of these plants, which are furnished with their proper cotyledonous matter as in other plants. "Pulvisculus" (these are his words) "igitur Muscorum intra capitula contentus, verum eorum est semen, quod, veluti aliorum vegetabilium semina, sua tunica, *cotyledone* unto et ultra, et plantulae rudimento instruitur."§ Notwithstanding, however, the truly ingenious and meritorious labors of this author, it still, I think, remains to be ascertained, whether the Mosses are really furnished with cotyledons, or not. Meanwhile, I follow the authors above mentioned, in retaining a head or class of acotyledonous seeds. 2. The Monocotyledonous seeds are such as have only one cotyledon, or lobe, in the seed. A seed of this kind contains with it a very entire embryo, without any perceptible chink, and is either entirely free, or at least loose from the rest of the kernel, at the extremity opposite to its radicle. Monocotyledonous are much more numerous than acotyledonous, plants. To the former head, are referred the great natural families of the Grasses, the Palms, the Scitamineæ,|| the Lilliaceous, and many other plants. Gærtner observes, that these seeds are of two kinds, viz. 1. the *true* monocotyledonous, having the embryo formed from its first production, of one individual body, and so composed of a medullary and cortical substance, that in every transverse section of the embryo, the double substance appears both distinct, and very entire: and 2. *false* monocotyledonous *(pseudomonocotyledonea)*, containing, as well as the former, a solid and undivided embryo, but at its first production, parted into distinct lobules, and afterwards, from the lobules being united at maturity, transformed into a solid and indi-

* Gærtner. † Class xxiv. CRYPTOGAMIA.

‡ "Musci et adfines (says Linnæus) solis Cotyledonibus destituuntur." Philosophia Botanica, &c. p. 89. §. 136.

§ D. Joannis Hedwigii, &c. Fundamentum Historiae Naturalis Muscorum Frondosorum, &c. Part II. p. 55. Lipsiae: 1783.

|| Class I. Monandria.

vidual body ; as in Tropœolum, Paullinia; and others. Gertner also divides the monocotyledonous plants into *true* and *spurious*. The true monocotyledonous plants observe one and the same mode of germinating and of growing, and, consequently, have the same habit of external form. To this head we refer the Grasses, the Cyperoideæ, the Lilliaceous plants, the great family of Orchides, the Scitamineæ, the Palms, and others. The spurious monocotyledonous plants only agree in the mode of germinating with one another, and with the former; whilst, in regard to their other qualities, they differ in almost every point; as in Nelumbium, Trapa, Ceratophyllum, Cuscuta, Orobanche, and others. Hence, a plant is generally named monocotyledonous, which springs from the shell (testa) of the seed, with a single true leaflet, or with a single filiform shoot, or *turio*. The Monocotyledonous plant which arises from the shell with a leaflet, is denominated phyllophorus, or leaf-bearing *(phyllophora)*; and that which arises with a filiform shoot is called turioniferous, or shoot-bearing *(turionifera)*. These last are either completely destitute of leaves *(aphyllæ)* ; as in Cuscuta and Melocatus ; or they are bulbiferous *(bulbiferæ)*, when the embryo of the seed is first elonogated into a fleshy staff, then the outer extremity of it is enlarged into a bulbous globule ; and from this globule arises the first leaflet. 3. The seeds which are furnished with two cotyledons, are denominated Dicotyledonous, and are by far the most frequent. They cherish within them an embryo, separating spontaneously into two lobes, or, at least, divided by a conspicuous chink, in the extremity opposite to the radicle. The dicotyledonous seeds are, in general, very readily distinguished from the others, because, in by far the greater part of them, the cotyledons are manifestly distinct from each other, as in the Garden-Bean, and many others.* In some of the seeds of this class, however, the diagnosis, as it is called, is attended with some difficulty. This difficulty occurs, when the cotyledons, now arrived at maturity, have coalesced into one undivided body; or, again, when in the more minute embryos, the chink of the division is so very small, that it cannot be properly distinguished, even when the eye is assisted by a magnifying glass. In the former case, it is advised to cut the seed before its complete maturity, or the mature kernel is to be determined and referred to its proper class, agreeably to the signs, already mentioned, when speaking of the false monocotyledonous seed†. In the latter case, it is useful, in many instances, to throw the doubtful embryo into a coloured liquor, very readily diffusible, such as that of the Phytolacca, or Poke, that this liquor may be received within the chink, and thus render it more conspicuous to the eye. If notwithstanding these precautions, we cannot satisfy our

* See Plate v. Fig. F.

† All the false monocotyledonous seeds according to Gærtner, properly belong to other classes, and most of them are dicotyledonous.

minds, then the seed is to be referred to the head of monocotyledonous seeds, even though we are certain, that it has originated from a genuine dicotyledonous plant. The greater number of dicotyledonous plants arise from the earth with two seminal leaflets *(folia seminalia,*)* but sometimes they leave their cotyledonous lobes hidden beneath the surface of the earth, and rise, to meet the light and air, with their plumule only. This difference has given occasion to distinguish the dicotyledonous seeds into 1. epigean, and 2. hypogean. The epigean *(epigœæ)* cotyledons are always the forerunners of the appearance of the new plant, and either resemble thick herbaceous lobes, as in the Kidney-Bean, and other Leguminous plants; or they resemble true leaves, in general, however different from those which are to follow, as in the compound flowers, and others; and they spontaneously fall off, after the plumule has unfolded itself. The hypogean *(hypogœæ)* cotyledons are only to be met with, in some of the exalbuminous seeds formerly mentioned, the testa, or shell, of which they very exactly fill, and never throw it off. They, therefore, always consist of thick and fleshy lobes, and these are either united, as in the Horse-Chesnut (Æsculus Hippocastanum,) &c. or they are distinct as in the Walnuts and Hickories (Juglans,) and others. These, for the most part, even before germination, cherish in their bosom, a manifest plumule, which, of itself, is capable of evolution. 4. The Polycotyledonous seeds are those which have more than two cotyledons; or, in other words, those in which the embryo is divided into more than two lobes. In general, they are easily distinguished from the other seeds already mentioned. The cotyledons are found to be more than two in various plants. Thus, there are three cotyledons in the Hemlock Spruce-Fir (Pinus canadensis;) four in Rhizophora gymnorrhiza, and in Avicennia; five in the Common Pine (Pinus sylvestris:) six in the Garden-cress (Lepidium sativum,) and ten, twelve, or more, in the different species of pine. In all these plants, the lobes are observed to be perfectly equal, except in Canarium and Lepidium. They are likewise, distinct in all, except Hernandia, the cotyledonous kernel of which is solid, and only many-parted, internally, by indistinct streaks. But polycotyledonous plants do not arise exclusively from these seeds; they are actually known to arise from acotyledonous seeds, as from Mnium hygrometricum, from Bryum trichodes and B. argenteum, and from various Fuci. Moreover, true dicotyledonous seeds sometimes counterfeit the polycotyledonous, namely when the nucleus, or kernel, owing to the abundance of nutriment, is divided into various irregular lobes, as in Mangifera domestica; or into minute bractes, which do not cohere with each other, as in the Shaddock (Citrus decumana:) but this structure is, unquestionably, monstrous, and cannot deceive the botanist who is well versed in inquiries of this nature.

* See Plate 5. Fig H. and Fig. O.

David Meese was of opinion, that there are no seeds furnished with more than two cotyledons;* and Mr. Adanson asserts, that the polycotyledonous seeds only differ from those which are dicotyledonous, in this, that the lobes of the former are again deeply divided, and that their lobes are, in reality, only two in number. The opinion of the French botanist has been implicitly adopted by many succeeding botanists, among whom I may mention the learned Mr. de Jussieu.† It is certain, however, that there are seeds entitled to the appellation of polycotyledonous seeds. This is evident from the unequal number of the lobes, as a ternary and quinary one, in some species of Pine. The polycotyledonous plants, however, are, on all hands, acknowledged to be but few in number.

As the number of cotyledons is upon the whole pretty constant, and rarely varies in the same family, so many botanists have founded their methods of plants chiefly upon the number of these parts. Thus, Ray, Boerhaave, Heister, Meese, Adanson,‡ and others, have assumed the number of the cotyledons as the basis of their systems, and have divided the vegetables of which they treat generally into Acotyledonous, Monocotyledonous, Dicotyledonous, and Polycotyledonous. This division is, likewise, the foundation of the celebrated, and, in many respects, natural method of Mr. de Jussieu, to which I shall have frequent occasion to refer, in the last part of this work. This distribution, however, does not afford classes of vegetables sufficiently natural for the purpose of the botanist: and is, moreover, liable to considerable difficulties. We cannot learn, with absolute certainty, the true number of the cotyledons, unless when we have an opportunity of inspecting the seed in a germinating state; nor will the fabric of the embryo, in every case, enable us to form a safe judgment of the number of the future cotyledons; for it is found, as has been already observed, that sometimes, as in the Mosses, a polycotyledonous plant proceeds from an acotyledonous seed; that from a monocotyledonous plant occasionally proceed plants which are close allied to the dicotyledonous plants, as in Dodder (Cuscuta,) and in Melocatus. Lastly, it is certain, that from a seed which is manifestly dicotyledonous, there may spring plants which are attended by only one cotyledonous leaflet; as in the genera Nelumbium and Trapa. Upon the whole, while it will readily be admitted, that although the number, the fabric, and physiology of the cotyledons are points which ought never to be neglected by the genuine botanist, it is highly improbable, that a methodical distri-

* Plantarum Rudimenta, &c. &c. 1763. 4°.

† Genera Plantarum, &c. p. 415. Mr. Curtis (*A companion* &c. p. 20.) positively asserts, that the seed of the Pine has only one cotyledon, and that what have been taken for the cotyledons "was, in fact, the plumule expanded into a considerable number of narrow leaves."

‡ This truly learned botanist has founded two systems on the cotyledons, the one on the number, and the other on the form, of these parts.

bution of plants from the number or form of these parts of the seed, will ever be generally received.

c. In general, when there are two or more cotyledons in a seed, they are equal, or of the same size, &c.: in some instances, however, we do observe a difference, both in regard to the size and thickness of the cotyledons. But germination finally abolishes the difference; and it is observed, that the cotyledons of the same seed, when evolved, are both very generally equal and very similar to each other. *d*. The size of the cotyledons is various in different vegetables. Most of the exalbuminous seeds have very large cotyledons; as in the Compound-flowers, the Verticillate plants, &c. On the contrary, in the Umbelliferæ, the Stellatæ, and some other natural families, the cotyledons are smaller. That is, in the first case they either fill the whole of the shell of the seed, so that when it is opened we observe nothing but the cotyledons and the radicle; or, in the second case, they are nearly of the length and breadth of the seed-shell, but owing to their albuminous matter do not completely fill it; or, lastly, they are sometimes hardly discernible, even by means of a glass: as in Heath (Erica,) Columbine (Aquilegia,) Ranunculus and others. Gærtner enumerates four heads of sizes of the cotyledons, viz. very large *(maximæ.)* middle sized *(mediocres,)* small *(parvæ,)* and minute *(minutæ.)* *e*. The absolute situation of the cotyledons is supposed to be always in the highest part of the radicle, although this be inverted, or those be turned to the side of the radicle, or rolled about it. But the relative situation respects the situation which the cotyledons hold among themselves, or in respect to the external regions of the seed. Cotyledons with respect to each other are, 1. *contiguæ*, contiguous; their internal surfaces touching mutually in every point; as in by far the greater number of known vegetables. 2. *oppositæ*, opposite; their internal surfaces mutually respecting each other; but, by reason of the inflected margins, either not able to touch each other at all, or not in all points; as in Meadow Crane's-bill (Geranium pratense,) Coldenia, and others. 3. *collaterales*, collateral; when one cotyledon is placed at the side of the other, in the same vertical plane, so that it is only at their internal margins that they can mutually respect or touch each other; as in the Misletoe (Viscum album,) Menispermum Coculus, and, in some measure, in Cachrys. 4. *divergentes*, diverging; joined at the base, but taking a contrary direction at the apex; as in Nutmeg (Myristica,) and Menispermum fenestratum. 5. *verticillatæ*, verticillate; placed in a circle, about a common point, so that they mutually touch each other; as in Pine, and Rhizophora. Cotyledons, with respect to the external regions of the seed, are, 1. *incumbentes*, incumbent; when one of the cotyledons respects the back, and the other the belly of the seed, so that the plane of mutual contact is parallel with the axis of the fruit, as in Henbane (Hyoscyamus) Campion (Cucubalus,) &c. 2. *accumbentes*, accumbent; when one respects the right and the other the left side of the seed, and the margins are turned to the back and belly of it, so that the plane of con-

tact is contrary to the axis; as in the Leguminous plants and others. 3. *transversales*, transverse; which have an oblique, or irregular situation in the seed, as in Myrsine, and Lathræa, &c. *f.* Almost all the known cotyledons have a continuity of substance, and a perfect equality of surface: yet some variation from these rules do occur. Thus, some cotyledons are, 1. *dentatæ*, toothed, or serrated in the margin; as in the Lime-tree (Tilia.) 2. *partitæ*, parted; their foliaceous plates more or less deeply divided into equal parts. 3. *rimosæ*, or *anfractuosæ*, chinky; having their thick lobes divided by chinks, and deep furrows, into various irregular lobes, cohering with each other, and not separated by an intervening membrane; as in Beech (Fagus,) &c. 4. *ruminatæ*, ruminate; like the preceding, except that the chinks are principally placed in the external surface; and separated by intervening membranous plates; as in the Chestnut (Fagus Castanea.) 5. *lobatæ*, lobed; when each primary lobe is again divided into other smaller lobes, on the exterior surface only; as in the Walnut. 6. *fenestratæ*, windowed; pierced with many round holes; as in a species of Menispermum, called, on account of this very singular structure, M. fenestratum. *g.* Very often the figure of the cotyledons is not different from that of the whole embryo, especially in the monocotyledonous and various other seeds: but, in most seeds, it is worthy of a separate consideration, and either according to the straightness or curvature of the plane of contact, or according to the circumcesure of the cotyledons. Thus, the cotyledons are, 1. *rectæ*, straight; when the internal surfaces, or plane of mutual contact, as well with respect to their length or breadth, hardly deviate from the right line. 2. *arcuatæ*, bowed; generally narrow, and always longer than they are broad: the axis, also, is curved in all, but the breadth of the surfaces is always straight and flat. 3. *reniformes*, reniform; the nearest to straight, as in the Leguminous plants. 4. *falcatæ*, sickle-shaped. 5. *uncinatæ* & *semicirculares*, hooked and semicircular. 6. *cochleatæ*, cochleate; which make one or two spiral turns; as in Cistus. 7. *vermiculares*, vermicular; bowed in an irregular manner; as in Scorpiurus vermiculata. 8. *flexuosæ*, flexuose. 9. *carinatæ*, keeled; the axis projecting into an angle, but the flattish sides bent either forwards or backwards; as in Privet (Ligustrum.) 10. *conniventes* or *subconduplicatæ*, converging, or somewhat conduplicate: these, from their situation, are opposite, and their sides are inflected in such a manner that the half of one plate is received within the duplicature of the other; as in Meadow Cranesbill and Coldenia. 11. *repandæ*, repand; the plates being curved in contrary directions, only near the margin, but, in the middle, are sufficiently flat, and are marked with a round angle; as in Tilia, Buckwheat (Polygonum Fagopyrum,) &c. 12. *plicatæ*, plaited; plaited like a ruffle into contiguous vertical or transverse wrinkles, as in Sebestena, &c. 13. *lacunosæ*, pitted; having their internal surfaces marked with rude and thick folds; as in Beech, &c. 14. *volutæ*, volute; differing from all the preceding, because their foliaceous and very broad plates are rolled in various ways

about a globe, or cylinder, or each other, and curved in all directions.* 15. *convolutæ*, convolute; strictly so called. 16. *cylindricæ*; cylindrical; simply rolled into a hollow cylinder; as in Pisonia. 17. *spirales*, spiral; the foliaceous plates rolled, in a spiral direction, about the radicle or plumule; as in the Pomegranate (Punica,) Myrobalanus, &c. 18. *duplicato-convolutæ*, doubly-convolute; having both margins reflected spirally into the middle of the internal surface; as in the Nelumbo. 19. *vaginantes*, sheathing; the outer plate cylindrically convolute, and embracing the internal, doubly convolute; as in Aubletia, Rivinia, &c. 20. *contortuplicatæ*, writhed, or contortuplicate; plaited and convolute in an almost inextricable manner; as in Mallow (Malva,) Cotton (Gossypium,) Convolvulus, and others.† "The proper figure of the cotyledons, which is defined by the limits of the circumference of the margins alone, and is equally common to the straight and curved cotyledons, has exactly the same modifications" that the true leaves (formerly considered) have, being, like them, linear, lanceolate, oblong, ovate, cordate, &c., except that the margins of the cotyledons are very rarely toothed or incised, and hardly ever irregular. As true leaves, so likewise the cotyledons have a different form in the different species of one natural genus or family. Thus, in the Tartarian Maple (Acer tataricum,) the cotyledons are gibbously flexuose, whilst in the Red-Maple (Acer rubrum,) they are spiral, &c. Thus, again, in the Mountain-Dock, or Sorrel (Rumex digynus,) they are quite straight, but in Bloody-Dock (Rumex sanguineus,) and in Blunt-leaved Dock (Rumex obtusifolius,) they are slightly curved, &c. &c. It is to be observed, however, that these differences, which are so very frequent in the true leaves, very rarely occur in the cotyledons. Indeed, it is very common for all the cotyledons of one genus or family, and even of two natural classes, to be very similar, and absolutely of the same form; as in the Umbelliferous plants and others. This circumstance must show the necessity, or at least the propriety, of carefully studying the history of the cotyledons, in every attempt towards a natural arrangement of vegetables. Indeed, without a minute attention to the cotyledons, we shall never possess what it is a matter of so much consequence to possess—A Philosophical History of the Vegetable Kingdom. *h.* The most common colour of the cotyledons is a pure milky white. Yellow-coloured cotyledons are not uncommon, especially in the ripe seeds of siliques

* To this head are referred cotyledons that are, 1. *concavæ*, concave, or spoon-shaped (*cochleariformes;*) as in Myristica officinalis. 2. *conglobatæ*, conglobate; formed into a sphere, which is smooth on the outside, but plaited within in various ways; as in Cabbage (Brassica,) &c.

† It is not expected, that students in botany, much less those who merely pursue plants as an object of pleasure, are to become thoroughly acquainted with this extensive and very difficult nomenclature of the cotyledons. In a work, however, such as the present, it would have been improper to have omitted this terminology, which we owe to the persevering industry and nice discrimination of the learned Gærtner.

and legumes. Some cotyledons are of a dark or grass-green colour.* In the seeds of the two genera Sonchus and Scorzonera, the cotyledonous matter is of a livid or leaden colour; and in the seeds of Bidens and Zinnia, it is of a purplish colour. But these colours are unusual, and they are all, by the great process of germination, converted into green; though sometimes into a fine-blood colour, as in some species of Amaranthus, &c. *i.* In regard to their odour and tastes, it is certain that, in general, the cotyledons have but little or no odour; or, at least, not a sweet or aromatic odour. For although the fruits of Cinnamon (Laurus Cinnamomum,) and Clove (Eugenia caryophyllata,) possess a very fragrant smell, yet this is entirely lost in the completely-matured cotyledons. In some seeds the taste of the cotyledonous matter is bitter, as in Quassia excelsa; in others, it is acrid, but very generally it is insipid and mealy, or sweetish, as in the recent kernels of the Almond (Amygdalus communis,) the Filbert (Corylus Avellana,) and different species of Walnut and Hickory, such as Juglans regia, J. nigra, Shell-bark Hickory (Juglans alba ovata,†) and others.

IV. The *Embryo* is the most noble and essential part of a fertile seed. It is the part which exclusively forms the *nova progenies,* or new plant, and to which all the other parts are added for its temporary use only. To this part L., after Andreas Cæsalpinus, gave the name of *Corculum,* or the little heart. Dr. Martyn calls it Corcle. Some writers have named it *plumula seminalis,*‡ or the seminal plumule. Adanson and Gærtner designate it by the name of embryo, a term which I do not hesitate to adopt in preference to either of the others which I have mentioned.§ According to Gærtner, the embryo derives its origin from the medullary point (*punctum medullare,*) produced by fecundation; and this point he thinks might more properly be named the corcle of the seed, "because in it alone resides the fountain of all vegetable life, and from it alone proceeds the whole vascular system of the embryo." In some cases the corcle is so little augmented, that even in the matured seed it is either altogether imperceptible, or it appears only like a paler point or dot, which Gærtner names the cicatricle (*cicatricula,*) and which has nothing of the embryo but the principle of life, (for the capacity of being roused to the possession of life,) and the faculty of germinating. In other cases the medullary point gradually passes into a columnar radicle, which projects above the kernel at its free apex, and at its base grows firmly to the same. Lastly, in other cases, the corcle, on all sides loose, grows at both of its extremities, from one of which it puts forth the radicle, and from the other the newly organized parts, which are named cotyledon and plumule.

* When, besides this colour, cotyledons have, likewise, a foliaceous figure, the seeds are said to be germinating (*germinantia,*) as in Nelumbo.

† Of Marshall.

‡ Professor Ludwig calls it Plantula seminalis.

§ See Plate V. Fig. C. 3. 4. Fig. F. 1. 1. 2. 3. Fig. G. 1. Fig. H. 1. 2. Fig. L. 1. Fig. N. Fig. O.

Hence there arises a four-fold difference of the embryo, from the increase of the corcle within the seed, viz. 1. *imperfectus*, imperfect; an embryo which, to use the words of Gærtner, is "merely potential," as being formed from the germinating cicatricle alone. 2. *incompletus*, incomplete; formed of a simple, fixed radicle alone. 3. *perfectus*, perfect; constructed of a free radicle and plumule. 4. *completus*, complete; composed of a radicle, cotyledon, and plumule. The *consistence* of the embryo in all is soft and herbaceous, fleshy, except in Rhizophora, the radicle of which is converted at maturity into an almost woody hardness. The *internal fabric* of the embryo is very simple, being formed from the medulla alone, and surrounded by its proper bark, in the more simple embryos. But in other embryos vessels are observable. These vessels arise from the lobules of the plumule or cotyledons by an insensible beginning, and gradually anastamosing or uniting with each other, they run through the whole substance of the embryo, and finish in its outermost radicle. This vascular structure is beautifully conspicuous in the embryo of the Persimmon (Diospyros virginiana,) when it is viewed through a magnifying glass.* The *external fabric* is generally owing to three distinct parts, which are peculiar to the embryo, and denominated the Plumule, the Scape, and the Radicle. Of these parts I shall speak, separately, afterwards. *a.* In regard to the figure of the embryo, it is to be observed, that this arises principally from the cotyledons, joined to the radicle, especially in the solid or true monocotyledonous embryos, which are almost entirely made up of the cotyledon alone, and frequently have a peculiar form, which is not to be met with in others. α. The solid or true monoctyledonous embryo is, 1. *trochlearis*, pulley-like; consisting of a short cylinder narrowed in the middle, or as if composed of two globules; as in Commelina, &c. 2. *pyramidalis*, pyramidal; rising from a broad radical base into an acute point, which is either longer or shorter, or cylindraceo-acuminate. 3. *fungiformis*, fungiform; from a narrow radical base, enlarged into a thick head or pileus; as in Carex, &c. 4. *patelliformis*, patelliform; from a very minute radical tubercle, extenuated into a round saucer; as in Flagellaria. β. The dicotyledonous and the remaining monocotyledonous embryos are, 1. *recti*, straight. 2. *crassi*, thick. 3. *foliacei*, foliaceous. 4. *curvi*, curved. 5. *arcuati*, bowed. 6. *falcati*, sickle-shaped. 7. *uncinati*, uncinate. 8. *cyclici*, cyclical. 9. *conduplicati*, conduplicate; having the radicle accumbent on the sides or chink of the cotyledons, or having generally the extremities either not at all separated; or at least only separated by a narrow space; as in Hemp (Cannabis,) and various Leguminous and Siliquose plants. 10. *spirales*, spiral. 11. *gnomonici*, gnomonic, or like a dial; having the scape inflected at a right angle; or having the radicle joined at an obtuse angle with the cotyledons. 12. *serpentini & sigmoidei*, serpentine and sigmoid; having the axis bent in a contrary direction near the two

* See Plate V. Fig. O.

extremities, or irregularly curved throughout its whole length; as in Lily (Lilium,) and Tulbagia, &c.

b. In regard to their situation, embryos are, 1. *centrales*, central; either filling the whole cavity of the shell, or placed only in its axis, and within the albumen; as in the greater number of seeds, particularly in the Umbelliferous plants. 2. *excentrici*, excentric; placed, indeed, within the albumen, but without the axis of the seed, yet so that they cannot touch the walls of the shell; as in Coffee (Coffea,) and Asparagus. 3. *peripherici*, peripherical; accumbent on the walls of the shell throughout their whole length, and, consequently, placed both without the axis and without the albumen; as in the Grasses, Pisonia, &c. *c.* The size of the embryo varies in different vegetables very considerably, but admits of the four degrees of measures which were mentioned in treating of the cotyledons. Indeed, as the cotyledons alone define the figure, so they generally define likewise the size of the embryo, and, not unfrequently, an embryo which, of itself, is very small, is observed to become very large, by the accession of cotyledonous matter; as in Scytalia sinensis. Thus, from the bulk alone of the cotyledons, we have embryos of the following heads of sizes, viz. 1. *maximi*, very large; as very generally in the Cucurbitaceous plants, the Compound-flowers, the Verticillate plants, the Siliquose, and other plants. 2. *mediocres*, middle sized; as in the Nightshades (Solanum,) and other Luridæ, &c. 3. *parvi*, small; in various Umbelliferæ, the Stellated plants, &c. 4. *minuti*, minute, in most of the monocotyledonous plants, such as the Orchideæ, the Cyperoideæ, Multisiliquæ, and others.*

d. The number of the embryos is very universally one. Sometimes, however, the number is increased by superfetation. Gærtner once observed two embryos in the seed of the Pinus Cembra: both were in the same cavity of the albumen, but one of them was inverted, the other, as is the usual case in the plants of this genus, was erect. It appears from the descriptions and engravings of some botanists, that a plurality of embryos does sometimes take place in the seeds of Misletoe (Viscum.) It is, I think, highly probable that such a plurality of embryos does occur with respect to many other plants; since we know, with certainity, that superfetation may and does take place in the vegetable world, as well as in some families of animals. *e.* In regard to its proper parts, the embryo, as I have already observed, consists of three parts, viz. 1. the *Plumula*, 2. the *Scapus*, and, 3. the *Radicula*. I shall now speak, at large, of these in the order in which I have mentioned them.

1. The Plumula, or Plumule, so called from its supposed resemblance to a little feather, is the upper part of the embryo, which (when the seed, after having been placed in a proper situation, and has begun to vegetate) rises upwards, forming all that part of the vegetable which

* Of all these natural families of plants, and many others, explanations are given in the course of this work.

appears above ground. Gærtner defines it "the first bud of the new plant arising from the scape of the embryo imprisoned in the seed, and ready to pass afterward into true leaves of the plant." Dr. Grew called this part the Plume.* The English name plumule seems preferable, especially as it is literally the import of the Latin word plumula, which almost all botanists have adopted. L. defines it "the ascending scaly part of the corcle: "pars corculi squamosa adscendens."† Many embryos are destitute of the plumule. This part is very constantly wanting in all the monocotyledonous seeds, except, perhaps, a few of the Grasses. It is, likewise, very often absent from the dicotyledonous seeds; or, at least, it is entirely concealed within the scape. Gærtner denominates these concealed plumules, *immersæ,* or immersed. On the other hand, the *plumulæ emersæ,* or immersed plumules, of the same writer, are always conspicious, and the radicles are placed in the vertex, yet in such a manner as to remain between the lobes of the cotyledons, and not to come into view except by removing these parts from each other; owing to the narrowness of the place, these kinds of plumules are always compressed, and have conduplicate leaflets, which are either simple or compound. The simple plumule *(simplex plumula)*, has sessile leaflets in opposite pairs: these leaflets are, 1. *tereti-acuminata,* cylindrical-acuminate. 2. *lineari-oblonga,* linear-oblong. 3. *lanceolata,* lanceolate. 4. *ovato-acuminata,* ovate-acuminate. 5. *convoluta-peltata,* convolute-peltate; as in Tropæolum. 6. *spiralis* spiral; as in Gyrocarpus Jacquini. The compound plumule *(composita plumula,* on the other hand, supports more than one leaflet upon a common petiole, and these are; 1. *conjugata,* conjugate; either two-paired, or bijugous *(bijuga*;) as in Arachidna, or many-paired *multijuga,* as in Juglans, &c. 2. *digitata,* digitate; this is very uncommon, but occurs in the Horse-Chesnut (Æsculus Hippocastanum,) and in Lupin (Lupinus.) 3. *coacervata,* heaped together; as in Lathyrus, Vicia, and others. These Gærtner acknowledges, seem properly to belong to the many-paired; but they may be designated by another name, since the leaflets are so closely crowded, and perhaps intermixed with the stipules, that from the minuteness of the parts, they cannot be easily distinguished from each other.‡ 2. The Scapus, or Scape, is much more frequently wanting in vegetables than is the plumule. Indeed, the greater number of embryos are scapeless, or destitute of this part. Gærtner, however, thinks proper to denominate those embryos caulescent, which are furnished with a very long radicle; especially a radicle which grows somewhat thicker downwards; as in Cestrum, and

* Dr. Darwin and other writers have adopted this name.

† Philosophia Botanica, &c. p. 54 §. 86.

‡ For representations of the plumule, see Plate v. Fig F. 2. Fig. G. I. Fig. H. I. Fig. N. Fig. O.

Persimmon (Diospyros virginiana ;*) or those in which the cotyledons are separated by a slender stripe from the somewhat swollen capitate radicle ; as in Misletoe, Barberry, &c. The same learned writer admits, that, in the greater number of embryos; certain limits between the end of the stem or scape, and the beginning of the radicle, are not given ; and that a great portion of almost all those scapes, whilst the business of germination is proceeding, descends into the earth, and is there evolved into a real radicle, or root. Consequently, every part of the embryo, that is placed beneath the cotyledons, may with propriety, be enumerated among the radicles. L. and most other writers make no mention of the scape, but divide the embryo (corculum) into two parts only, viz. the plumule, and the radicle. But although the scape be frequently wanting, there does seem to be a propriety in designating by this separate name; a part of the embryo. 3. The Radicula, or Radicule, is by far the most constant part not only of the embryo, but of the whole kernel : for we find it in those seeds which have no other vestige of the embryo. The name of radicle was given to this part of the seed by Dr. Grew, and has been retained by Ludwig, Gærtner, and the greater number of the modern botanists. L. however, thought proper to designate this part of the embryo by the name of *Rostellum*, and defines it "the simple descending part of the corcle ; "pars corculi simplex descendens."† In almost all the seeds which have, hitherto, been examined, we find only a single radicle *(radicula solitaria)* to each embryo. This is the observation of Gærtner, who examined the seeds of 1054 plants, belonging to distinct genera. Some embryos, however he admits are furnished with more radicles than one. Thus, three, four, or six together of such *(radiculæternæ, quaternæ, senæ,)* properly formed and distinct from each other, are found in the seeds of Rye (Secale,) Wheat (Triticum,) and Barley (Hordeum,) "but in no other seeds hitherto known."‡ It is probable, however, that the radicle is less constantly solitary than Gærtner imagined. The fibres, or roots, of this part of the embryo may, in numerous instances, be distinct, but, owing to their minuteness, and cohesion by means of mucilaginous or glutinous matter, they may seem to constitute only a single, undivided body. I think, I have, in one instance, distinctly observed several radicles to a single embryo of the Persimmon. *a.* In regard to its figure, the radicle is, 1. *puncticularis*, puncticular ; appearing like a mere white point in a kernel, which, in every other respect, is solid ; as in the Mosses, and other more imperfect plants. In all other cases the radicle projects. 2. *tubercularis*, tubercular ; but little different from a thicker solid dot or point ; is in Pepper (Piper,) and Flagellaria. 3. *conica*, conical ; arising from the cotyledons with a broad base, and ending quickly in a point ; as in Enchanter's-Nightshade (Circæa,) and many other plants. 4. *teretiu-*

* See plate v. Fig. N. and Fig. O.
† Philosophia Botanica, p. 54. §. 86. ‡ Gærtner.

scula, roundish. 5. *filiformis*, filiform. 6. *cylindrica*, cylindrical. 7. *fusiformis, vel clavata*, fusiform, or clubshaped as in Coffee, various Leguminous plants, &c. 8. *capitata*, capitate; as in Zinnia, Viscum, and Berberis. 9. *ovato-globosa*, ovate-globular; as in Cassyta, and in all the minute and globular embryos; for in these the radicle forms the principle part of the embryo, as in Sundew (Drosera,) and others. 10. *recta*, straight; as is the case with most short radicles. 11. *curva*, curved; as in most of the long radicles. *b.* In regard to its length, the radicle is, 1. *longissima*, very long; that is, longer than the cotyledons; as in Rhizophora, Anguillara, and others. 2. *æqualis*, equal: that is, as long as the cotyledons; instanced in most of the Umbelliferous plants, and others. 3. *brevis & previssima*, short and very short; that is, shorter than the cotyledons; instanced in all the monocotyledonous plants such as the Verticillatæ, &c. in the Persimmon;* &c. *c.* The proper situation of the radicle always seems to be at the base of the embryo; but the *relative* situation has a reference to the other internal parts of the seed; and, in an especial manner, to the recepticle of the fruit and seed. As to the other internal parts of the seed, and especially with regard to the albumen, the situation of the radicle suffers exactly the same modifications, which the embryo itself does; hence radicles are, 1. central. 2. excentric. 3. peripherical. But, from their combination with the cotyledons, a new relation arises amongst these parts, and thence the radicle becomes, 1. *directa*, direct; continuing to run out in one line with the axis of the cotyledons, whether it be straight or curved; and at the base of the cotyledons does not suddenly take any other course, as in the straight, sickle-shaped, hooked, bowed and cochleate embryos. 2. *inclinata*, inclined; the axis being joined, at a right or obtuse angle, with the axis of the cotyledons. 3. *reflexa*, reflected; suddenly recurved near the base of the cotyledons, towards their other extremity, and is either accumbent on their sides or chink; as in the conduplicate embryos, especially of the Siliquose and Leguminous plants. 4. *involuta*, involute; constituting the axis of the embryo, about which the cotyledons are so rolled, as to conceal a very large part of the radicle; as in Ayenia, Pomegranate (Punica,) and others. As to the proper receptacle of the fruit or seed, which is a relation of situation of great consequence to be attended to, the radicle is, 1. *supera s. ascendens*, superior or ascending, respecting the apex of the fruit with its point. Those radicles are denominated simply superior, which tend directly upwards, and rise from the highest part of the seed; as in the Unbelliferæ, Asperifoliæ, and others. Those are named ascending, which arise from the base or side of the seed, and tend upwards at their apex; as in Hemp, Corrigiola, &c. 2. *infera s. descendens*, inferior or descending, respecting the base or peduncle of the fruit with its apex. A radicle is strictly named inferior, which rising from

* See Plate v. Fig. N. and Fig. O.

the bottom of the seed, tends directly downwards; as in the Compound-flowers, the Verticillate plants, and others; and it is named descending, when, rising from the highest part of the embryo, it tends towards the base with its apex; as in Meesia, Marvel of Peru (Mirabilis,) and others. 3. *centripetæ,* centripetal; either absolutely or relatively such. In a simple fruit, the former respect the axis, or common receptacle of the seed with their apex; as in Tulip (Tulipa,) Tobacco, and others. In a conjugate or many-capsuled fruit, the latter are, indeed, turned to the common axis, but in partial pericarps only respect the internal side; as in Helicteres, Monkshood (Aconitum,) Larkspur (Delphinium,) and others. 4. The *centrifugæ,* or centrifugal radicles, are, *unilaterales* unilateral, or one-sided; all respecting one side of the pericarp; or; in a naked seed; the circumference of its horizontal plane; as in Beet (Beta,) Goosefoot (Chenopodium,) and others; *bilaterales,* bilateral, or two-sided; turned to two directly opposite regions of the pericarp; as in Bog-Bean (Menyanthes trifoliata, &c.) the Siliquose plants, and others; *multilaterales,* multilateral, or many sided; directing their points to different places, or to every surface of the dissepiments and internal parietes, or walls; as in Cistus Helianthemum, the Cucurbitaceous plants, and others: *vagæ,* vague; which have not the same certain situation in all seeds, but are directed with their points towards different parts; as in Ginger (Zingiber,) Water-Lily (Nymphæa,) and others. Such are the various modifications to which the tender embryo is liable. It continues "imprisoned within its seed," and remains (to use the happy expression of Gærtner) "in a profound sleep," until it is awakened by the approaching germination, and meets the light and air to grow into a plant, similar to its parent. But, even in its encumbered or involved state, the embryo *possess* life, which, however, is not *obviously* active, and by no means of equal duration in all. Or, if we deny to the quiescent and slumbering seed, an inherent principle of life (whatever that may be,) we must, at least, admit that its embryon, and other, parts are endowed with a peculiar (and, as yet, incomprehensible) *capacity* for receiving life, from the agency of heat, water, air, and other stimuli. Having finished the consideration of the various parts of the kernel (I mean the more technical history of these parts, for several important points in their natural history remain to be discussed,) I proceed, in the next place to treat of some other parts of the seed, in general. These parts are, 1. the *Pappus.* 2. the *Coma.* 3. the *Cauda.* 4. the *Ala.* and, 5. the *Crista.* All these are, by Gærtner, denominated accessary parts of the fruits and seeds ("partes fructuum atque seminum accessoriæ,") because they may be present or absent, without injury to the structure of the seed. It would, perhaps, have been better to have treated of these accessary parts, along with the testa, and other integuments of the seed; but, upon the whole, I have thought it more proper to treat of them, in this place after the consideration of the kernel, especially as the principle of these parts are chiefly instrumental in the propaga-

tion of the *ripe* seed. 1. The Pappus,* or Aigrette, is a sort of feathery or hairy crown, with which many seeds, especially those of the Compound-flowers, are furnished, evidently intended for the great business of the dissemination or dispersion of the seed, to a considerable distance. The word pappus is commonly translated Down;† "but hence, (as Dr. Martyn observes) arises a confusion between this and the *lanugo* or *tomentum* on the surface of leaves, &c." which both in Britain and the United States, is generally called down. Some writers translate this word by Feather, but there are objections to this word. The French call it aigrette. "The ladies have adopted that term: why may not we?" L. explains the pappus to be "a feathery or hairy flying crown to the seed;" "Corona (seminis) pennacea, pilosave volitans."‡ Different kinds of pappus are enumerated by the botanists: Thus we have, 1. *pappus sessilis*, a sessile aigrette; or a down placed immediately upon the seed, in the form of a crown; as in Hawkweed (Hieracium,) in Goates-Beard (Tragopogon,) and others. 2. the *pappus stipitatus*, or stipitate aigrette, is supported on a thread, called the stipe, and elevated by it considerably above the vertex of the seed; as in Common Dandelion (Leontodon Taraxacum,) and many others. The pappus is likewise, 1. *capillaris*, or capillary, and 2. *plumosus*, or feathery. The capillary aigrette, or pappus, is simple, having the hairs undivided;§ as in Silk Cotton-tree (Bombax pentandrum,) Groundsel (Senecio,) Golden-rod (Solidago,) and various other Compound flowers. The feathery aigrette, on the contrary, is not simple, but branched, like a feather; having in other words, setaceous or chaffy rays, with lateral hairs, which are always capillary.

Other species of pappus are enumerated; such as, 1. *aristatus*, awned; having one, two, three, and sometimes more, short rigid rays, often hooked backwards; as in Bidens. 2. *stellatus*, stellate; consisting of five filiform, and attenuated and spreading rays; as in Geropogon. 3. *spinosus*, thorny; having acinular and pungent rays; as in Zinnia. 4. *setaceus*, differing from capillary (above mentioned) only in the greater rigidity, and more numerous teeth; as in Chrysocoma. 5. *ciliatus*, ciliate; between setaceous and feathery. 6. *lanatus*, woolly; in which the vertex of the seed is crowned with a white ring, formed of a very short and dense wool; as in Cineraria glauca. *b*. In regard to its dura-

* In the Latin language this word has the following significations, viz. a grand-sire, an old man, thistle-down, and several others. In this last sense, it is employed by Lucretius (Lib. 1. 387.)

† Thus Sandays:

> "Like scatter'd down, by howling Eurus blown
> By rapid whirlwinds from his mansion thrown."

‡ See Philosophia Botanica, &c. p. 54. §. 86

§ Although the capillary pappus is very slender, like a human hair, it is, nevertheless, marked with very minute teeth, which are sometimes nearer, sometimes more remote from each other.

tion, the pappus is, 1. *peristens*, permanent; continuing with the seed; and, of course, this species of aigrette is peculiarly favourable to the dispersion of seeds. 2. *caducus*, *s. fluxilis*, caducous, or very temporary: this is less common than the other, and is principally given to the larger and heavier seeds, as those of Thistle (Carduus,) Cotton-Thistle (Onopordum,) and others: it is, however, found in the smaller seeds also, as in those of Sow-Thistle (Sonchus,) Lettuce (Lactuca,) and others. By some writers this last mentioned kind of aigrette is denominated *pappus deciduus*, or deciduous aigrette. A knowledge of the aigrette is of essential consequence in the study of botany. L. very generally employs the many varieties which obtain in this minute and delicately organized part of the plant, in discriminating the different genera of the plants of his class Syngenesia. Gærtner has, certainly, very unjustly denied L.'s attention to the pappus. Vaillant, a long time ago, always attended to this part of the fructification in drawing the characters of his genera; and it is certain, that he examined and defined it with uncommon care: "Whence (says Gærtner,) his genera are much preferable to those established by L." The aigrette, as I have already observed, is evidently intended for the great business of the dissemination or dispersion of the seeds. This is, indeed, one of the wonderful contrivances employed by the liberal hand of nature for distributing her vegetable productions over the surface of the earth. There can be little doubt, that many species of plants, particularly among the Compound-flowers, owing to their being supplied with the aigrette, are now the common inhabitants of many parts of the world, in which, originally, they were unknown.

2. The Coma is very nearly related to the pappus; for, like it, it is formed of hairs which are placed upon the vertex of the seed, and collected into a bundle. According to Gærtner, it differs from a pappus, because in the coma the hairs derive their origin from the shell of the seed, and not from the proper calyx of the flower; and because all the comate seeds are furnished with a true pericarp; as in Willow-herb (Epilobium,) and others. These, therefore, according to the same botanist, are improperly considered as pappous seeds.

3. The Cauda, or Tail, resembles a slender stipe, proceeding from the vertex of the seed, hairy from the base to the apex, and, in the naked seeds, produced from the persisting style of the ovary; but in the covered seeds, from the testa, or shell. In both these cases, the cauda is much longer than the seed; as in Virgin's Bower (Clematis,) in Pasque-flower (Anemone Pulsatilla,) &c.

The hairy tail, which proceeds from the base of the ovary, as in Cat-tail (Typha,) and Plane-tree, or Button-wood (Platanus occidentalis,) is to be accounted a mere and simple peduncle of the fruit.

4. The Ala, or Wing, is a broad, flexible, and membranous expansion, fixed to the vertex, back, or sides of certain fruits and seeds, and thus facilitating their dispersion. When it occupies the vertex and back, it is especially denominated a wing: but when it surrounds the sides, it is called a Margin (*Margo.*) L. thus defines the wing: "*Ala*, mem-

brana, qua volitante disseminatur, affixa semini."* Seeds that are furnished with wings, are, 1. *unialata*, one-winged, as in Mahagoni (Swietenia,) and others. 2. *trialata*, three-winged; as in Moringa. To this head may also be referred the seeds of Rhubarb (Rheum,) and Buck-wheat. 3. *quadrialata*, four-winged. I believe we have not, hitherto, discovered any examples of four-winged seeds, except in the genus Combretum. A membranous margin (*Margo membranaceus*,) is not uncommon in seeds, and occurs very differently formed. Thus, it is, 1. *planus & integer*, flat and entire; as in Allamanda, and others. 2. *apice & basi emarginatus*, emarginate, at the base and apex; as in Lilac (Syringa,) &c. 3. *cymbiformis*, boat-shaped; as in Marigold (Calendula,) &c. 4. *bullatus*, bullate; appearing like blisters; as in Cynoglossum omphalodes. 5. *in dorsum reflexus*, reflected upon the back, and forming spurious cells, as in Arctotis, &c.

The preceding terminology applies principally to seeds. But pericarps, also, are furnished with the ala or wing. Such pericarps have received the following names, viz. 1. *monopterygia*, one-winged; being furnished with only one wing; as in Ash (Fraxinus,) and others. 2. *dipterygia*, two-winged; as in the conjugate fruit of Maple (Acer,) and in Halesia diptera, an American vegetable. 3. *tripterygia*, three-winged; as in Begonia, &c. 4. *tetraptera*, four-winged; as in the beautiful Halesia tetraptera, and in Tetragonia. 5. *pentaptera & polyptera*, five-winged, and many-winged; as in Guaiacum, and in Crown-Imperial (Fritillaria,) and others. The membranous margin is not uncommon in some of the more compressed pericarps; as in Shepherds-purse (Thlaspi,) and others: but in seeds it is much more common.

5. The Crista, or Crest, is very nearly allied to the wing, but is narrower, less flexible, and formed of a coriaceous or cork-like matter, and always placed on the back of fruits. The crista has received different names. Thus, it is, 1. *serrata*, serrated. 2. *laciniata*, laciniated. 3. *dentibus incisa*, toothed. 4. *crispata*, curled; as in Daucus, and others. Besides the preceding, Gærtner has enumerated other accessary parts of fruits and seeds: such as 1. *Rostrum*, a Beak; generally proceeding from the peristing style, as in Stone-crop (Sedum,) Hellebore (Helleborus,) and others. 2. *Costæ & Juga*, Ribs and Ridges; elevated, rounded, or muricated furrows, placed on the back of seeds or pericarps, and separated from each other by flattish intermediate spaces; as in Horn-Beam (Carpinus,) the umbelliferous plants, and others. 3. *Strophiola*, Strophioles; these are fungous, glandular, or callous epiphyses, generally of an oblong form, and to be found only upon the ventral side of the seed; as in Wild-Ginger, or Asarabacca (Asarum canadense,) and others. 4. *Spinæ*, or Thorns. 5. *Glochides*, Barbs. 6. *Verrucæ*, or Warts. 7. *Squamæ*, Scales. 8. *Pubes*, Pubescence. 9. *Pruina*, Hoariness, and others. Most of these accessary parts of the seed, and pericarp, have already been mentioned, in treating of the different kinds

* Philosophia Botanica, &c. p. 54, § 86.

of fulcres, as L. calls them. It is unnecessary, therefore, to say any thing further on the subject in this place. Beside the semen, or seed, properly so called, two other terms are referred to this general head by L. these are, 1. the *Nux*, and, 2. the *Propago*.

1. The Nux, or Nut, is a seed covered with a shell. L. thus defines it, "Semen tectum epidermide osseo."* Gærtner defines it, "a hard conceptacle, either not opening at all, or, if it do open, never separating into more than two valves." The following account of the nut is principally taken from this truly meritorious author. The nut has an affinity, on the one hand, with capsules, and, on the other hand, with drupes. Sometimes it is even referred to the naked seeds. From the capsule, it differs in the total want of valves, and in the base often having a scraped or filed appearance to some distance. From the drupe, it differs in the manifest nakedness of the putamen, or shell; or if there be a rind, in the incomplete opening at the apex. Lastly, it differs from the naked seeds in the remarkable thickness of the putamen; the easy separation of it from the kernel, and the manifest umbilical vessels placed within the cavity of the putamen, as in Cotton-grass (Eriophorum,) many of the Asperifoliæ, &c. *a.* In regard to its integuments, the nut is, 1. *nuda*, naked. (By far the greater number of nuts are naked, or, at least, clothed with a cuticle which is hardly discernible.) 2. *glabra*, smooth. 3. *splendens*, shining. 4. *rugosa*, wrinkled. 5. *subpubescens*, somewhat pubescent. 6. *corticata*, corticated; covered with a rind (*cortex:*) this rind is either membranous, and frequently extended into a wing, or ribs, as in Pine, Houndstongue (Cynoglossum,) and others; or coriaceous and thick, as in Juglans. The latter are nearly allied to dry drupes. 7. *involucrata*, involucred. Nuts are more generally supplied with an involucre than any other species of pericarps; as in Chesnut, Beech, Yew, Juniper, Hazel, Oak, and others.† *b.* In regard to its consistence, the nut is, 1. *sicca*, dry. 2. *firma*, firm. 3. *dura*, hard. 4. *coriacea*, coriaceous; as in Chesnut, and others. 5. *crustacea*, crustaceous; as in many of the Rough-leaved plants. 6. *cavernoso-coriacea*, cavernose-coriaceous; as in Cashew (Anacardium,) and in Acajuba. 7. *ossea*, bony; as in Walnut Hazel, &c. 8. *lapidea*, stony; as in Myosotis, and others. *c.* In the nut, there is no spontaneous opening before the germination of the seed; nor does the number of the valves, in any instance yet known, exceed two. The English Walnut (Juglans regia,) alone has a manifest suture. Trapa alone opens with a hole at the vertex. Many of the nuts open at the base, or at their insertion, with a round aperture, or chink; as in Lycopsis arvensis (Small Bugloss,) and others. *d.* In regard to its internal fabric, the nut is, 1. *simplicissima*, very simple. 2. *unilocularis*, unilocular, or one-celled; as in by far the greater number of nuts.

* Delineatio Plantæ.

† Several of the seeds here denominated nuts, are referred by L. to other heads.

3. *bilocularis,* bilocular, or two-celled; as in Cerinthe and Trapa. Very few nuts are two-celled. 4. *trilocularis,* trilocular, or three-celled; as in Beech and Oak. 5. *semiquadrilocularis,* half-four-celled; as in Chesnut. From this view of the subject, it is evident that nut is a pretty comprehensive term, embracing a considerable variety of seeds, such as those of the Chesnut, Beech, Chinquepin, Walnut and Hickory, Hazel, Oak,* Juniper, Yew, Oil-nut,† and others.

2. Propago is the name of the seed of the Mosses. It is thus defined by L: "Semen *Musci* decorticatum, detectum 1750."‡ The Swedish naturalist supposed that these seed differed from other seeds in having a naked corcle (embryo,) without bark or cotyledons. He informs us that he made this discovery in 1750. A few years after this period, David Meese asserted that the seed of the Mosses are furnished with their proper cotyledons. The industrious Hedwig, as has already been observed, also asserts, that the seed of this great family of plants are, like those of other plants, supplied with cotyledons. Gærtner admits the existence of acotyledonous plants, and refers to this head the Mosses.§ By this author the Propago is considered as a species of gemma, or bud, perfectly simple, and destitute of true leaflets, assuming different forms, sometimes entirely naked, and sometimes shut up in a bark-like case; which, at length, separates spontaneously from its parent, and is scattered like a seed. The bulb-like granules ("grana bulbiformia") of G. C. Oeder‖ are referred to this head.

I resume the consideration of the seed in general.

a. In regard to the number of the seeds, this is a very variable circumstance in different vegetables: 1. Some plants have only a single seed.¶ This is the case with the Sea-Pink (Statice Armeria,) and Bistort (Polygonum Bistorta.) 2. Some have two seeds, as Woodroof,** and the Umbelliferous plants. 3. Some have three, as Spurge (Euphorbia.) 4. Some have four, as the greater number of the Lip-flowers of Tournefort, and the Rough-leaved plants of Ray. 5. Some have many seeds, as Ranunculus, Anemone, Poppy, Lobelia, Ludvigia, Gerardia, and others. The fertility of nature in the production of seeds is almost incredible, and is a circumstance well calculated to display the unbounded liberality of nature, and the immense quantity of life that may spring from a solitary embryo. A single stalk of Indian-Corn (Zea Mays,)

* The cup of the acorn is denominated by late writers, *cupula*.

† A new Pentandrous genus of plants, allied to Nerium. It is a native of Pennsylvania, Virginia, and other parts of the United States.

‡ Philosophia Botanica, &c. p. 54. § 86. "*Propagines Muscorum* sunt semina destituta tunica & cotyledonibus, adeoque nudi corcula Plumula, ubi Rostellum infigitur calyci plantæ." Ibid. p. 57. § 88.

§ See Class XXIV. CRYPTOGAMIA.

‖ Elementa Botanicæ, &c. Pars prior. p. 35. Hafniæ. 1764.

¶ That is, in each pericarp.

** Asperula odorata.

produced in one summer 2000 seeds: in the same period, a plant of Elecampane (Inula Helenium,) produced 3000 seeds: the Common Sunflower (Helianthus annuus,) 4000: the Poppy 32,000. A single spike of Cats-Tail (Typha,) produced 10,000 seeds and upwards. A single capsule of the Tobacco was found to contain 1000, and one of the White-Poppy (Papaver somniferum,) 8000 seeds. Each capsule of the Vanilla contains from 10,000 to 15,000 seed. Mr. Ray informs us, from actual experiments made by himself, that 1012 Tobacco seeds are equal in weight to one grain; and that the weight of the whole quantity of seed in a single stalk of Tobacco, is such, that the number of seeds, according to the above mentioned proportion, must be 360,000. The same learned naturalist estimates the annual produce of a single stalk of Spleen-wort (Asplenium,) to be upwards of one million of seed. Dr. Woodward has calculated, that a single Thistle-seed will produce at the first crop 24,000 seed; and, consequently, five hundred and seventy-six millions of seeds at the second crop!! Well might Virgil say, that the Thistle becomes " dreadful in the corn-fields."

Our admiration cannot but be excited by this fertility. Yet it is more wonderful, as has been observed,* that in some plants such a prodigious number of ovules can be fecundated by very few stamens; and that in other plants, even a very moderate quantity of ovules cannot be fecundated by a numerous set of stamens. It is worth observing, in this place, that very generally plants which are distinguished for the number of their seeds, are those which have the fewest stamens or anthers. Thus Vanilla has but one anther, and the Tobacco five; whilst, on the other hand, among the Polyandrous plants (most of which have many stamens,) there are not a few vegetables, which are scarcely equal to the fecundation of a single ovule.† These facts must lead us to believe that the fecundation of seeds is owing more to the *quality* or peculiar virtue of the pollen than to the mere *quantity* of this fecundating powder. Thus, I have found, that the pericarp of the Crown-Imperial (Fritillaria imperialis,) swelled as completely from the influence of only one anther as from the whole number, which is six, of those male organs of generation, in this vegetable. These facts must, likewise, show us (and it is a circumstance fortunate for mankind,) that every vegetable ovule is not destined by nature to give rise to a future progeny. The same remark, unquestionably, applies to the animal, as well as to the vegetable world. Millions of embryos pre-exist, but never are evolved into active life.

As the number of the seeds is so extremely variable in vegetables, it must be evident that genera constructed merely from this quality of the

* By Gærtner.

† It must, however, be remembered, that the Poppy is, at once, remarkable for the number of its stamens and its seed; and that among the *Orchides*, many of which have only a single anther, there are not a few individuals, which very rarely do furnish us with a prolific seed.

fructification, must be artificial and precarious. Thus Gleditsia triacanthos (Honey-Locust,) has a legume with several seed; whilst another species (Gleditsia monosperma,) has only a single seed in its legume. Many other instances of a like kind might be mentioned. Nay, even in the same species, the number of the seed is often indefinite. Thus, in Persimmon (Diospyros virginiana,) we find the fruit with one seed, with two, three, four, five, six, seven, and eight seed. It must be confessed, however, that in many families and natural genera of vegetables, the number of the seeds is pretty constant and invariable.

b. In regard to its figure, the seed is, 1. *subrotundum*, roundish. 2. *ovatum*, ovate. 3. *oblongum*, oblong. 4. *scobiforme*, scobiform, or saw-dust like; resembling saw-dust. 5. *filiforme*, filiform. 6. *turbinatum*, turbinate. 7. *clavatum*, club-shaped. 8. *angulatum*, angular. 9. *cylindraceum*, cylindrical. 10. *triquetrum*, triquetrous. 11. *acerosum*, acerose. 12. *teres*, columnar. 13. *ellipticum*, elliptical. 14. *lunulatum*, crescent-shaped. 15. *cordatum*, cordate. 16. *reniforme*, reniform. 17. *orbiculatum*, orbicular. 18. *globosum*, globular. 19. *arillatum*, arilled; furnished with an aril. 20. *planum*, flat. 21. *hinc planum, inde rotundum*, flat on one side, and round on the other. 22. *hinc rotundum, inde angulatum*, round on one side, angular on the other. 23. *compressum*, compressed. 24. *gibbum*, gibbous. 25. *angulis membranaceis*, with membranous angles. 26. *acuminatum*, acuminate. 27. *obtusum*, obtuse. 28. *rostratum*, rostrate. 29. *erectum*, erect. 30. *marginibus membranaceis*, with membranous margins. 31. *emarginatum*, emarginate. 32. *caudatum*, tailed; terminated by a naked or feathery filament. 33. *carinatum*, keeled. 34. *squamatum*, scaly.

c. Seeds, it is hardly necessary to observe, vary remarkably in size. It may, however, be remarked, that Gærtner has established four heads of sizes of the seed, viz. 1. *magnum*, large; not smaller than a walnut, or which exceeds a geometrical inch; whether it be extended in thickness; as in Lontarus maldivica* and Cocoa nut (Cocoa;) or in length, as in Rhizophora. 2. *medium*, middle-sized; between an inch and two lines;† neither larger than a Hazle-nut or smaller than a Millet-seed. 3. *parvum*, small; exceeding half a line; but not greater than two lines, contained within the limits of the seeds of Bell-flower (Campanula,) or a Poppy. 4. *minutum s. exile*, minute; smaller than the preceding, and often like dust or powder, as in Chara, in the Ferns, in the Mosses, &c.

d. In regard to its surface, the seed is, 1. *glabrum*, smooth; having no conspicuous inequalities or splendour on its surface; as in Radish, Cabbage, and others. 2. *lævigatum*, polished, smooth and shining; as in Amaranthus, Sapota, &c. 3. *lucidum s. splendens*, lucid or shining; the surface shining, but not perfectly smooth; as in Corn-Gromwell

* The pericarp of this plant (which is a berry,) is frequently a foot and a half in thickness.

† The line is the twelfth part of an inch.

(Lithospermum arvense,) &c. 4. *striatum*, striated; having either longitudinal streaks, as in Hemlock and other Umbelliferæ, or transverse or oblique streaks; as in Exacum; or radiated ones, as in Tradescantia. 5 *sulcatum*, furrowed; marked with thick streaks, either simple or branched; as in Fool's Parsley, (Æthusa Cynapium,) Ipecacuanha (Psychotria,) and Pimpinella agrimonoides.* 6. *cancellatum*, latticed; having the longitudinal streaks, or furrows, decussated by transverse and generally narrower ones; as in Glaucium, Argemone, Onopordum, &c. 7. *reticulatum*, reticulated; differing from the former in the irregularity only of the streaks; as in Pennywort (Hydrocotyle,) &c. 8. *scrobiculatum*, scrobiculate; marked with rather large pits, distant or contiguous; as in Euphorbia Tithymalus. 9. *punctatum*; dotted or punctate; either excavate-punctate (*excavato-punctatum*,) or elevate-punctate (*elevato-punctatum*,) with the dots disposed in series, or irregular. Such seeds are common in the Luridae, and other natural families. 11. *apiculatum*, apiculate; rough, with very short and frequently capitate bristles; as in Drosera. 12. *tuberculatum*, tubercled; rough with thicker elevated dots, or tubercles; as in Hydrocarpum. 13. *papillosum*, papillous; covered with flexible scales, or fleshy tubercles; as in Eryngo (Eryngium,) and in Codon. 14. *vermiculatum*, vermiculate; marked with elevated serpentine streaks, or a species of foreign letters; as in Balsam-apple (Momordica,) &c. 15. *marginatum*, marginate; either thickened at the margin; as in Cucurbita, or extenuated at the margin (*marginaceo-extenuatum*,) as in Allamanda. 16. *rugosum*, wrinkled; rough with tubercles, streaks, and pits irregularly intermixed; as in Aconitum, &c.

e. In regard to their colour, there is a very considerable variety in the seeds of plants. This is the more remarkable, because the seed is the only part of the vegetable which, without having received the free access of light, is decorated with fine colours. It is moreover to be observed, that the colours of seeds are such as rarely occur in the coloured parts of flowers, but on the contrary the most generally prevailing colours of the flower are extremely uncommon in seeds.

The following are the principal colours of different seeds, viz. 1. *melinum*, honey-coloured. 2. *rufescens, reddish*. 3. *helvolum*, pale-red. (These three are the most common colours of seeds, and the least common in flowers.) 4. *ochraceum*, ochrey. 5. *ferrugineum*, rusty. 6. *castaneum*, chesnut-coloured. (These, after reddish, are the most frequent colours of seeds, and are hardly ever observed in flowers.) 7. *nigrum*, *atrum & anthracinum*, black, and different varieties of black. These are colours nearly peculiar to seeds; for we have no instances of flowers entirely black, though there are some that have black spots. I may add, that we have many instances of black or

* To this head belong the following, viz. 1. *costatum*, ribbed, and, 2. the *malendinaceum*, molondinaceous, or mill-stone-like, seed, so named from the thickness or breadth of the dorsal furrows; as in Caucalis, &c.

blackish pericarps; as in Podalyria australis, Cassia marilandica, and others. 8. *fuscum*, brown. 9. *testaceum*, tile-coloured. 10. *spadiceum*, bay. (These are common in the seeds and bark, but very unusual in flowers.) 11. *album*, white. 12. *lacteum*, milky. 13. *niveum*, snowy. (These are more frequently to be met with in flowers than in matured seeds: yet seeds, before maturity, are, very generally, white.) 14. *rubrum, coccineum & rutilum*, red, scarlet, or crimson, and fiery: these colours are very common in flowers, but much rarer in seeds. In Gloriosa, however, in Abrus precatorius, and in others, we meet with fine scarlet and other red seeds. 15. *roseum*, rosy. This is a very frequent colour in flowers, but very rarely observed in seed. In Pomegranate, however, we have an instance of it. 16. *cæruleum*, blue. Blue seeds are extremely rare, but they do occur in Croton cyanospermum, and in a variety of Kidney-Bean. (Phaseolus vulgaris.) 17. *subcærulea*, or somewhat blue, and *plumbeo-livescentia*, lead-livid, seeds are met with in Zingiber, and some other plants. 18. *viride*, green. (Although green is so predominant a colour in the vegetable world, it is extremely uncommon in seeds. In some plants, however, as in Adonis vernalis, and in Yellow-Balsam, or Touch-me-not (Impatiens noli me tangere,*) grass-green seeds do occur. Yellowish-green (*lutescenti-viridia*,) seeds occur in different species of Bird's-foot-Trefoil (Lotus,) and others. 19. *variegatum*, variegated; as in Lathyrus, Phaseolus, &c. All the preceding colours, not to mention others, are assumed by seeds, when they are ripe. Colour is, therefore, very generally considered as a proof of the maturity of seeds. It is to be observed, however, that the seeds of many vegetables remain colourless, during the whole term of their life. Moreover, the colour frequently varies from the influence of culture, and by age is often changed from a paler to a darker, becoming, from straw-coloured, reddish; from reddish, rust-coloured; and, from rust-coloured, brown. "Hence, (as Gærtner observes,) colour can neither be taken for a certain sign of maturity, nor for a distinctive specific mark: but it serves to distinguish a seed from the neighbouring parts, and especially from Pyrenes."† Our author considers that coat as the proper outermost integument of the seed, which is distinguished, by its peculiar colour, from the neighbouring coats.

f. In regard to its consistence, the seed is 1. *ex-succum*, juiceless. 2. *duriusculum*, hardish. 3. *amygdalino-carnosum*, almond-fleshy; a seed retaining the impression of the nail. 4. *fungosum s. suberosum*, fungous, or cork-like; a seed which can be opened by scratching. 5.

* Balsamina Noli tangere of Gærtner.

† Pyrenes, according to Gærtner, are nothing but partial putamens, or the bony coats of single cells, often again divided into partial chambers, entirely separated from the neighbouring ones which resemble them. But for more minute information concerning these parts of the pericarp, I must refer the curious reader to Gærtner's work, *De Fructibus*, &c. &c.

coriaceum, coriaceous; which can be cut with a knife. 6. *crustaceum*, crustaceous; which can be broken by the fingers. 7. *nucamentaceum s. osseum*, nucamentaceous, or bony, which can hardly be broken in pieces between the teeth. 8. *baccatum*, berried.

g. For particular information concerning the situation of the seed, I must refer the reader to the work of Gærtner. I shall only observe, that the situation of these parts is of great consequence in defining the limits of the genera of plants; and is of the highest importance in a philosophical view of the seed; for Gærtner has shown that the situation of the seed is the most constant of all its extrinsic qualities. This botanist determines the situation, partly from the figure, partly from the insertion of the seed, and in part from the direction of the radicle of the embryo. As. L. has denominated the pericarpium the "ovarium fœcundatum," or fecundated ovary, so he denominates the seed, the "egg of plants."* To these analogical terms there can be no particular objections. A knowledge of the pericarp and seed is of the utmost importance in the study of botany: I mean in the methodical distribution of plants, and in investigating their affinities to each other. In a philosophical and physiological point of view, the dignity of these parts will be immediately seen and acknowledged. We shall afterwards see, that L. almost always attends to these parts of the fructification in drawing the generic character of vegetables. By other botanists, the fruit has been deemed of still more importance. Thus, Rivinus has founded the orders of his system upon the fruit. The great Tournefort has done the same. Camelli constructed a method upon the valves of the fruit: and although L. has declared, that in determining the genera of plants, the flower ought to be greatly preferred to the fruit, his opinion on this subject has not received the sanction of *all* the botanists since his time. Thus, Gærtner is of opinion, that for the purpose I have mentioned, the two parts in question are nearly equally entitled to attention, "for Nature (he observes,) has made flowers and fruits equal in dignity." This is unquestionably the case.

A. I.—Of the Migration of Seeds.—Nature has employed various modes for effecting the diffusion of the seeds of vegetables over the surface of the earth. The principal of these modes are the following, viz.

1. Rivers, and other running waters. The seeds of many vegetables are carried along by rivers, and torrents, and the ocean, and are frequently conveyed to the distance of many hundred, or thousand, miles from the countries in which they were originally placed. In this manner, many of the plants of Germany are conveyed to the shores of the sea in Sweden, various plants of Spain and France are carried to the shores of Britain; and the plants of Africa and Asia are often conveyed

* See Philosophia Botanica, &c. p. 92. § 146. "Omne vivum ex ovo; per consequens etiam vegetabilia: quorum Semina esse *Ova*, docet eorum Finis, so bolem parentibus conformem producens." Ibid. p. 88. § 184.

to the shores of Italy. Sir Hans Sloane has given an account of four kinds of fruits, which are frequently thrown by the sea upon the coasts of the islands of the northern parts of Scotland. These seeds, or fruits, were Mimosa scandens; Horse-eye-bean (Dolichos pruriens,) Ash-coloured Nickar-tree (Guilandina Bonduc,) and the "Fructus orbicularis sulcis nervisque distinctus,"* of Caspar Bauhin. All these are American vegetables,† and three of them were known by Sloane to be natives of Jamaica. These and several other kinds of seeds, which are likewise found abundantly upon the coast of Norway, were thought by our author to have been brought by currents, through the Gulf of Florida, into the North American ocean. Dr. Tonning has mentioned several other seeds which are annually thrown upon the coasts of Norway: such as those of Cashew-nut (Anacardium occidentale,) Bottle-gourd (Cucurbita lagenaria,) Dog-wood-tree (Piscidia Erythrina,) and Cocoa-nut (Cocos butyracea.) These are often in so recent a state, that they would unquestionably vegetate, were the climate favourable to their growth and existence. And, doubtless, they are frequently carried to countries in which they do vegetate as well as in the countries where they were originally placed by the hand of the Creator. Dr. Darwin observes, that the fact of the emigration of these seed is "truly wonderful, and cannot be accounted for but by the existence of under currents in the depths of the ocean; or from vortexes of water passing from one country to another, through caverns of the earth." It does not, however, I think, seem necessary to adopt this conjecture of the English poet; but I can, with great pleasure, refer my readers to his pretty lines on the voyage of Cassia from the "brineless tides" of Lake Ontario, to the coasts of Norway.‡

2. Winds. I have already taken notice of the dispersion of plants by means of the winds. It is hardly necessary to say any thing further on the subject in this place. I may observe, however, that the vegetables which are carried by the wind, are either winged, as in Fir-tree (Pinus Abies,) in Trumpet-flower, (Bignonia radicans,) Tulip-tree (Liriodendron Tulipefera,) Arbor vitæ (Thuya occidentalis,) and some of the Umbelliferæ, not to mention many others: or they are furnished with an aigrette, as in the plants formerly enumerated when treating of this part; or they are placed within a winged calyx or pericarp; as in Statice Armeria, Ash, Maple, Elm, Log-wood, Woad (Isatis;) or, lastly, they are contained within a swelled calyx or seed-vessel; as in Ground-cherry (Physalis viscosa, &c.,) Melilot (Trifolium Melilotus,) Bladder-nut (Staphylea trifolia,) Bladder-sena (Colutea arborescens,) Heart-seed (Cardiospermum,) and many others. With respect to all these vegetables, it is certain that, owing to the peculiar structure of their pericarps or seeds, they are very extensively diffused over the surface of the earth;

* Strychnos colubrina? of L.

† They are likewise natives of the East Indies.

‡ The Loves of the Plants. Canto iii. l. 411. 418.

and in this way, there can be no doubt, that we are to explain the circumstance of many of these vegetables being found in remote and opposite parts of the globe, as in North America and Asia. Thus, the Erigeron canadense, or Canadian Flea-bane, which was brought to Europe in the seventeenth century, has spread over a great part of that continent; and the Common Dandelion is often seen growing upon the highest towers of towns and cities. This last mentioned vegetable, is not, I think, a native of North America, but it has already been carried to very distant parts of the continent, and in a few years will be as extensively diffused as any of our vegetables.

3. Birds and other animals are no mean agents in the dissemination of vegetables. Birds, in particular, are greatly instrumental in this business. They swallow the seeds, which they discharge entire, and thus scatter them, with their excrements, over the face of the earth. In this manner the seeds of Common Misletoe, and those of some species of Loranthus, are deposited in the crevices of the barks of vegetables, where they grow, and continue to receive their nourishment. In the United States the former of these vegetables is very frequently found growing, as a parasite, to the branches of the Sour-Gum (Nyssa integrifolia,) the Apple-tree, and others. Different species of Turdus, or Thrush, are especially concerned in its diffusion. Loranthus americanus, which is a native of the West Indies, is deposited upon the branches of the most lofty trees, particularly Coccoloba grandifolia; where it is most firmly fixed, and unquestionably receives its nourishment from the supporting vegetable.* Rumphius assures us, that a particular species of Pigeon is very instrumental in disseminating the true Nutmeg in the East India islands. It is in this way that the Poke (Phytolacca decandra,) the berries of which are eaten by the Robin (Turdus migratorius,) the Thrush (Turdus rufus,) the Wild Pigeon (Columba migratoria,) and many others, appears to have been so extensively diffused through North America. The Rev. Mr. Robinson, in his *Natural History of Westmoreland and Cumberland*, has very particularly mentioned a thick grove of Oak trees, which were known to have sprung from the acorns that had been planted by a great number of crows, about twenty-five years before. Of the North American birds that are known to us, no one I believe is more instrumental in planting groves of Oaks, and other trees, than the Crested-Crow, or Jay-bird (Corvus cristatus,) which is extremely provident in laying up great stores of acorns, and other seeds, in the holes of fence-posts, and other similar places. There seems to be little doubt, that the very regular growth of many of our forest-trees along the courses of fences, is to be ascribed, in part, to the agency of this and other species of birds, as well as some species of quadrupeds. Besides the birds, many other animals have been greatly instrumental in the dispersion of the seeds of vegetables. Squirrels, rats, and other animals, suffer many of the seeds

* Professor N. J. Jacquin.

which they have devoured to escape, and thus disseminate them. Our Indians are of opinion, that the squirrels plant *all* the timber of the country. This I do not suppose; but it is certain, that they contribute not a little to this end, by depositing in the earth, for food, store-houses of various kinds of nuts and seeds, such as those of the Chesnut, Oaks of different kinds, Walnuts and Hickory-nuts, the seeds of the Common Dogwood (Cornus florida,) and many others. Immense numbers of these seeds, even though there were not a great destruction of the squirrels, would vegetate and grow to a good size. But as there is annually a prodigious destruction of these quadrupeds, whole forests cannot but spring from the stores which they have laid up. It has, indeed, been asserted,* that the Striped Dormouse, or Ground-Squirrel (Sciurus striatus,) previously to depositing in the earth its winter food, takes the precaution of depriving "each kernel of its germ, that it may not sprout." Were this assertion founded in truth, it would constitute one of the most interesting facts in the history of animal instinct or reason. But, although the little quadruped of which I am speaking, may, on many occasions, deprive the kernel of its germ, or embryo, (not, I presume, to prevent its growth, but because the embryo, in almost all seeds, has a very delicate and agreeable taste,) it is certain that, in the greater number of instances, no such mutilation of the seed is accomplished, and that, therefore, innumerable seeds that have been planted by animals, may, and actually do, grow into trees, and other vegetables. Animals contribute to the dispersion of seeds in still another way. The seeds of many plants attach themselves to animals, especially quadrupeds, by means of hooks, crotchets, or hairs, which are either affixed to the seeds themselves, as in Hounds-tongue (Cynoglossum,) Mouse-ear (Myosotis,) Vervain, Water-Hemp Agrimony (Bidens,) and many others; to their calyx, as in Burdock (Arctium Lappa,) Agrimony, Rhexia, Dock (Rumex,) Nettle, Pelletory (Parietaria,) Linnæa, &c. &c.; or to the pericarp, or seed vessel, as in Liquorice (Glycyrrhiza,) Enchanter's Nightshade (Circæa,) Cleavers (Galium Aparine,) Triumfetta Bartramia, Martynia, Pea-Vines (Hedysara, of various species,) not to mention many others. In this manner, there can be no doubt that many seeds are very extensively diffused over vast tracts of country. Thus, there are good reasons to believe, that neither Common Hounds-tongue (Cynoglossum officinale,) nor Burdock, are natives of the United States: but both of these plants, which appear to have spread in the manner I have mentioned, are now to be seen in many of the most remote parts of the Union.

The very incorruptible nature of the seeds of plants, is a circumstance highly favorable to their migration.† We have seen, that the seeds of Misletoe, Loranthus, Poke, and others, vegetate very well,

* By my very respectable friend, the late Dr. Jeremy Belknap, of Boston.

† J. J. Plenck. Physiologia et Patholigia Plantarum, p. 92. Viennae: 1794. 8vo.

after they have been subjected to the digestive power of birds. Nay, it is a fact, that some seeds, when carried to a distance from their native countries, have generally refused to vegetate, until they have been passed through the alimentary canal of birds. In Britain, this was found to be the case with the seeds of the Common Magnolia, or Beaver-tree (Magnolia glauca.) This fact will excite less surprise, when it is recollected, how extremely tenacious seeds are of the vital principle; or, in other words, how difficult it is to prevent seeds from living. Thus, the late illustrious Spallanzani discovered, that there are certain kinds of seeds, which do not refuse to vegetate, even after having undergone the operation of boiling in water: and Duhamel mentions an instance of seeds germinating after they had experienced, in a stove, the heat of 235 degrees by the scale of Farenheit. Spallanzeni even found, that the seed of mould, which is a true vegetable, survive a heat infinitely greater than this. We are, moreover, well assured, that the seeds of certain species of plants, after having been preserved in the cabinets of the curious, for whole centuries, have vegetated very readily, when committed to the earth, or when simply irrigated with water.

4. Many seeds are dispersed to a considerable distance by means of an elastic force, which resides in some part of the fructification. In the Oat, and in the greater number of the Ferns, this elasticity is resident in the calyx. In Centaurea Crupina, it resides in the pappus, or aigrette; whilst, in many others, such as Geranium, Herb-bennet (Geum urbanum,) Fraxinella (Dictamnus albus,) Touch-me-not (Impatiens,) Cucumber (Cucumis,) Wild-Cucumber (Momordica,) Horsetail (Equisetum,) and many others, it resides in the capsule. The pericarp of Impatiens consists of one cell with five divisions, each of which, when the seed are ripe, upon being touched, suddenly folds itself into a spiral form, leaps from the stem, and scatters, by virtue of this elastic property, its seed to a great distance, Dr. Darwin has mentioned this phenomenon, in his learned and charming poem, *The Loves of the plants*:*

The pericarp of the Geranium, and the beard of the Wild-Oat (Avena fatua,) are twisted, doubtless, for a similar purpose, and, being extremely sensible to the changes of the atmosphere, readily dislodge their seeds on wet days, when the earth is best fitted to receive them. Advantage has been taken of this property of the pericarp of the Geranium, of which an ingenious and neat hygrometer has been constructed.† The Wild-oat, called "Walking-Oat," is now familiarly known to every body. The awn (arista) of the Barley is furnished with stiff points, which are all turned towards the point of it, like the teeth of a saw. As this long awn lies upon the ground, it extends itself, during the prevalence of the moist night-air, and pushes

* Canto iii. l. 131-134.

† See Dr. Withering's Botanical Arrangement, &c. Vol. III. p. 597 & 598.

forwards the grain of Barley which it adheres to. In the day-time, it shortens as it dries, "and as these points prevent it from receding, it draws up its pointed end; and thus, creeping like a worm, will travel many feet from the parent stem."* Surely, these facts may, with some propriety, be mentioned as instances of the migration of the seeds of plants.

B. II. Of the Germination of the Seed.—The seed after having been impregnated by the animated pollen, or fecundating powder, of the anthers, is at no great distance of time, in a fit state to germinate. Some seeds, indeed, begin to vegetate long before they are detached from the pericarp, or vegetable womb; in which they have received their existence, and passed through some of the tranquil stages of their life. This is the case with the Tangekolli and Agave, formerly mentioned. Mr. Baker assures us that upon dissecting a seed of Trembling-grass (Briza) he plainly discovered, by the assistance of the microscope, a perfect plant furnished with roots, sending forth two branches, from each of which there proceeded several leaves, or blades, of grass,† In the Persimmon, the germination of the seed commences long before the fall of the fruit, and even before the fleshy part of it is quite matured: for in the unripe fruit we plainly discern, even with the naked eye, the two beautiful leaves of the embryo, that are afterwards to form the upper part of the tree.‡. "So in the animal kingdom (as Dr. Darwin observes,) the young of some birds are much more mature at their birth than those of others. The chickens of pheasants, quails, and partridges, can use their eyes, run after their mothers, and peck their food, almost as soon as they leave the shell; but those of the linnet, thrush, and blackbird, continue many days totally blind, and can only open their callow mouths for the offered morsel."§ In the greater number of vegetables, however, there is no germination of the seed, exterior to its shell, until after the opening of the pericarp, and the fall of the seed. The germination is then accomplished by different circumstances, which are more or less necessary to this great function of vegetable life. These circumstances are Earth, Air, Water, and Heat. Of each of these, and of some other supposed agents in the business of germination, I shall speak, in a very brief manner, in the order in which I have mentioned them.

1. Although earth is not essentially necessary to the germination of the seed, it is extremely useful, affording a proper situation, a maternal bosom, for this vegetable egg, where it can repose, fix itself, and receive the influence of the various agents, which are more indispensibly

* Darwin.

† In the seeds of the Nymphæa Nelumbo, and in those of the Tulip-tree, the embryo-leaflets are so similar to those of the adult vegetables, that L. merely from an examination of these leaflets, was enabled to discover to what vegetables the seeds belonged. See Amoenitates Academicæ, &c. Vol. VI. Dissertatio cxx.

‡ See Plate v. § Phytologia, &c. Sect. ix.

necessary to the evolution of its parts. I do not deny, that earth of certain kinds, may be actually absorbed by, and serve as aliment to, the growing seeds of vegetables. I even think it probable that this is the case. But this is one of those points, in vegetable physiology, which has not yet been satisfactorily decided by experiments.

Innumerable facts, however, might be adduced to show, that earth is not absolutely necessary to the germination of seeds. We have seen, that the seeds of various parasitic plants vegetate very well in the chinks of the bark of other vegetables. Some seeds vegetate upon the most barren rocks, where they can hardly be said to have a particle of earth. But, what is more to our purpose, the seeds of many plants vegetate in the water, and continue, during the whole course of their lives, very completely detached from the earth.* Moreover, seeds of various kinds germinate very readily and rapidly, upon cotton, wool, feathers, sponges, cut paper, and other similar matters, provided they be kept constantly moistened, with water, and exposed to the proper quantity and species of air. Seeds never vegetate in a very dry earth. The greater number of them will vegetate in any kind of earth, provided it be moist. Even in moist earth, when they are buried at a great distance below the surface, they remain in a profound sleep, and make no visible effort to vegetate, until they are brought much nearer to the surface. They are always later in coming up, in proportion as they are planted deep in the ground. Bierkander, a Swedish writer, has instituted some curious experiments relative to the germination of seeds, of various kinds, at different depths under ground. He found, that the seeds of Flax would never germinate when they had been buried lower than a certain depth, in the earth. He also, found, that the seeds of this plant would not vegetate in sand.

2. The vast influence of air upon the vegetation of the seed might be shown by many facts. Seeds do not vegetate in *vacuo*, or, if they do vegetate, their growth is precarious and feeble. The celebrated chemist William Homberg, towards the close of the xviith century, made a number of experiments with different seeds placed under the receiver of the air-pump. He observed, that the seeds of Lettuce, Purslane, and Cresses, do sometimes come up in vacuo, but that the number of them is small, and that the leaflets that made their appearance, perished soon after. Boyle, Musschenbroek, and Boerhaave concluded, from their experiments, that the access of air is indispensibly necessary to the germination of the seed. Pease, however, are said to grow in vacuo. It is, no doubt, owing to the want of air, that seeds which are planted very deeply in the ground, refuse to germinate. But they vegetate very readily when the ground has been ploughed or turned up, and the seeds, in this way, are more immediately exposed to the contact of the atmosphere. The seeds of Black-Oats after having lain deeply buried in the soil of Scotland, for half a century, have grown vi-

* See Class xxiv. CRYPTOGAMIA.

gorously as soon as they were raised near enough to the surface to receive the influence of the air. It is well known, that many seeds do not readily germinate, if soon after they have been planted rains have fallen. In this case, a kind of crust is frequently formed upon the earth, which prevents the access of air. Different seeds seem to require very different quantities of air, in order to further their germination. On this subject, indeed, our knowledge is not very precise. The acorns of some species of North-American Oaks vegetate much quicker when merely laid upon the surface of the earth than when buried at some depth below. The seeds of the Long-leaved Pine (Pinus palustris) vegetate very readily upon the surface of the naked sand, without the least covering of earth; and the nuts of different American species of Æsculus, or Horse-Chesnut, such as the Buckeye (Æsculus flava,) grow as well, if not better, upon, than beneath, the surface of their most proper soils. In order that seeds may readily germinate, it is not only necessary, that they be exposed to the influence of the air, but that the air be pure, or, at least, as pure as that of the atmosphere. The experiments of Mr. Achard and many other philosophers have plainly proved, that these vegetable ova will not germinate in azotic gas (or phlogisticated air,) in carbonic acid-gas (fixed air,) nor in hydrogen gas (inflammable air.) The Abbe Spallanzani, however, has shown, that the seeds of various species of plants do vegetate very well in confined or stagnant air, provided there be a plenty of this air.* The same remark applies to the eggs of many species of insects, and other animals, notwithstanding the assertions of the great Boerhaave, and other writers to the contrary. Unquestionably, however, pure air is peculiarly favorable to the germination of the seed. Thus, Huber, who has devoted much attention to this interesting subject, has shown, that seeds which had refused to vegetate in azotic gas, did vegetate when to this gas he added a small portion of oxygen gas.† He has likewise shown, that the first developement of seed is more rapid in this gas than in the common air. It would, indeed, seem that it is oxygen gas alone that gives to seeds their first determination to germinate; just as the same gas seems to be the first exciting cause of the movements of the irritable fibre of the embryo-chick, *in ovo.* It is not improbable, that many of the seeds of the plains and valleys, when carried to the summits of high mountains, refuse to vegetate there, in some measure, from the circumstance of their having in the elevated regions of the atmosphere, a smallar quantity of oxygen gas than in the climate below. The very ingenious F. A. Humboldt has

* Experiments and observations upon animals and vegetables confined in stagnant air. English Translation.

† According to the modern chemists, the atmosphere of our globe is composed of azotic gas and oxygen gas, in the proportion of about seventy-three parts of the former and twenty-seven parts of the latter. The carbonic acid gas (or fixed air,) is deemed an accidental part of the atmosphere.

shown, that Pease and French Beans that had been sowed in sand, and watered with water to which was added oxygenated muriatic acid, grew much more quickly than those which were irrigated with water alone. The same seeds perished when they were watered with water to which was added the simple muriatic acid: which plainly proved, that it was the oxygen of the acid, and not the acid itself, which had so greatly disposed the seeds to germinate. When the seeds of the Garden-cress (Lepidium sativum) were watered with the diluted oxygenated muriatic acid, they exhibited their leaflets at the end of six hours; but the same seeds were only thus far advanced in germination, at the expiration of thirty-six hours, when they had been watered with common water. At Vienna, where professor Jacquin and others have paid much attention to this curious and really important subject, it was found, that certain old seeds, which had always refused to vegetate, were brought to vegetate by irrigating the earth in which they were planted, with water to which was added the oxygenated muriatic acid. This was found to be particularly the case with the seeds of Dodonæa angustifolia, and Mimosa scandens. Mr. Humboldt has, also, shown, that seeds which were planted in the calces of metals (which are all compound bodies consisting of the reguline matter, or metal, and oxygen,) such as the oxydes of lead, called red-lead, and lytharge, if they be irrigated with water, will more readily vegetate than when committed to the earth; and that they will not vegetate when planted in the powder of the same metals, not in the state of oxydes. These various facts, the discovery of which may be said to constitute an important era in the science of Vegetable Physiology, prove in the most satisfactory manner, that oxygen gas, or vital air, is absolutely necessary to the complete developement of the embryo of the seed. It is proper, however, to observe, that the purest oxygen gas, and even common air entirely freed from its carbonic acid, are less proper for the germination of the seed, than oxygen gas to which is added a portion of azotic gas; or than the atmospheric air in union with a pittance of carbonic acid gas. It, moreover, appears, that common atmospheric air is better adapted to the germination of the seed, but particularly to the progress of the plant, after it has acquired more size and strength, than is oxygen gas. These facts are calculated to show the great affinity of animal and vegetable life: nor are they without their value in a practical point of view. It is highly probable, that the seed, as well as the more adult plant, is capable of decomposing the carbonic acid, that may be offered to it, detaching the oxygen of this acid from its radicle or base, which is carbon.* As air is so indispensible an

* Chaptal and some other chemists have asserted, that plants live in azotic gas, "and freely vegetate in it." My colleague Dr. James Woodhouse informs me, that, in a *solitary* instance, a *single* seed of Water-Mellon had germinated very well in this gas. We are certain, however, that *almost* universally the gas in question is highly unfavorable to the germination of the seed, and to its future progressive growth.

agent in forwarding the germination of the seed, it must be obvious, that where we wish to prevent seeds from vegetating, we should carefully seclude them from the air, especially a warm and moist air;* by covering them, and keeping them in a cold and dry place. In this manner, they may be preserved for ages. There can be no doubt, moreover, that the seed will be preserved for a much longer time in an air less pure than in one more pure. Accordingly, it is the practice of many who keep seeds for curiosity, to put them in glass vessels, with a litttle sulphur, or camphor, and well corked. From what will presently be observed, it would appear probable, that the preservation of seed will be still further effected by keeping them more in the light, than in dark situations.

3. Water is another of the indispensible agents in forwarding the vegetation of the seed. No seeds will germinate if they be placed in a situation where the air is perfectly dry. Hence seeds which are kept perfectly dry in the cabinets of the curious, and in similar situations, never vegetate, but the same seeds begin to sprout in a very short time, when they are irrigated with water. The seeds of aquatic plants will not vegetate unless in water, or in a very moist soil. But the seeds of many of the land-plants perish if they be kept too moist. Each seems to require a certain determinate quantity of water to further its germination. In general, those seeds which have a loose testa, or shell, require more water for their germination than those whose shell is more close.

4. A certain degree of heat is indispensibly necessary to the germination of the seed. During the severe weather of the winter-season, the seeds which have been placed in the earth do not germinate, but remain inactive in a state perhaps very similar to the torpid condition of many animals, but on the coming on of spring, the "penetrative sun"† rouses the embryo, from its slumber, into active life.

It is unnecessary to dwell upon this subject, for the agency of heat, in the business of germination, is familiar to every one. I shall only add, that from the influence of heat upon the seed, we learn, that the period of its germination is not a determinate law in respect to time. The same seed which, in an ordinary degree of heat, requires six hours to germinate, may be brought to this state in three hours, by exposing it to a greater degree of heat. In this respect, as well as many others, there is a great affinity between the seeds of plants and the eggs of birds.

* Some seeds, we are told, keep best when they are exposed to the air, whilst others have their determination to germinate preserved by a total exclusion from the air. Mr. Miller informs us, that the seeds of Parsley, Onion, Lettuce, and other vegetables, that were kept in vials hermetically sealed, for a whole year, did not germinate, while those of the same age, hung up in bags, in a dry room, vegetated freely. For much valuable information concerning the best method of preserving seeds, I must refer the reader to Mr. Ellis's *Directions for bringing over Plants and Seeds, &c.* See, also, Mr. Curtis's *Companion to the Botanical Magazine*, &c. pages 27-33. † Thompson.

This observation may, I believe, be extended to the eggs of some of the amphibious animals, such as the serpents.

5. Although the influence of light upon plants that have made their appearance above the earth is extremely great, and indispensably necessary to the healthy state of the vegetable, it is certain, from actual experiments, that light is not necessary to the first germination of the seed. Mr. Fourcroy and other writers have indeed asserted that light is necessary to this function of the vegetable egg. But the contrary has been shown by numerous experiments, as those of Curtis, Ingen-housz, and other writers. Nay, it has been ascertained, that seeds, which have never felt the influence of the solar light, vegetate more quickly than those which have received its influence. Many plants, originating from seeds, grow and come to perfection in the darkest mines, and in other similar situations.

Dr. Ingen-housz and Mr. Senebier have both shown that seeds which were planted in the dark vegetated sooner than those which were planted in the light. The Abbe Bertholon has opposed this idea. This respectable writer supposed that the seeds would actually vegetate quicker in the light than in darkness, provided they could, in both instances, be exposed to the same quantity of water. To determine this point with certainty, Mr. Senebier made the following experiment. He placed Peas, Beans, and French-Beans (Haricots,) upon sponges which were equally wetted, and enclosed them in vessels of a given size. He exposed some of them to the light of the sun, and by them others in cases of tin plates, painted of a deep red colour. They were all exposed to the same degree of heat. The water which might evaporate from the sponges was prevented from escaping, so that, upon this ground, there could be no source of deception. The germination proceeded much more rapidly in the darkened cases than in those which were exposed to the influence of the light. The very different effects of light upon the seed, and upon the more evolved and adult vegetable, is one of the various circumstances which seem to render it highly probable that light and heat are fluids essentially distinct from each other,* however frequently they may be combined together.

6. Electricity deserves to be mentioned in this place. It must be remarked, however, that authors are much divided in opinion concerning the real effects of this fluid upon the germination of the seed. Dr. Darwin observes that "the influence of positive or vitreous electricity in forwarding the germination of plants and their growth, seems to be pretty well established."† Mr. D'Ormey is said to have found various seeds to vegetate sooner and to grow taller when they were put upon his insulated table, and supplied with electricity. Mr. Bilsborrow's experiments, which are recorded by Dr. Darwin, seem to prove, that

* See the fine experiments of Dr. Herschel, and other writers. See also Darwin's Phytologia, &c. Sect. XIII.

‡ Phytologia, &c. Sect. XIII.

Mustard-seed which were subjected to positive or vitreous electricity, and to negative or resinous electricity, vegetated much sooner than seeds which were not electrised, "but otherwise exposed to the same circumstances." The Abbe Bertholon, whom I have already mentioned, is of opinion, that both natural and artificial electricity increase the germination of the seed, and the future growth of the plant. Dr. Ingenhousz, from his experiments, was obliged to deduce a very opposite conclusion; and Mr. Senebier, in a very late publication, concludes, that the influence of the electrical fluid is, "at least, doubtful."*

7. There are, doubtless, many other agents which exert an effect more or less decided on the germination of the seed. It is probable, that most of the various manures which increase the living powers of the more adult plant, exert a similar effect upon the embryo within its shell. But the very different effects of light upon the seed and upon the evolved plant, should teach us the propriety of treating this subject with caution. Meanwhile, I think it may be confidantly asserted, that various stimulants such as nitre (nitrate of potash,) common salt (muriate of soda,) green vitriol (sulphate of iron,) blue vitriol (sulphate of copper,) gypsum or plaster of Paris (sulphate of lime,) charcoal, and many others, if they be applied in their proper dose, exert a considerable effect in hastening the germination of the seed.

The time at which different species of seeds, after having been committed to the earth, begin to vegetate, is exceedingly various. Thus, Millet (Milium,) and Wheat, vegetate in one day; Kidney-Bean, Mustard, and Spinach (Spinacia,) in three days; Lettuce and Fennel (Anethum Fœniculum,) in four days; Cucumber, Gourd, and others, in five days; Beet and Radish, in six days; Barley in seven days; Orache (Atriplex,) in eight days; Cabbage, in ten days; Beans (Faba,) from fifteen to twenty days; Onion, from nineteen to twenty days; and Parsley (Apium Petroselinum,) from forty to fifty days. Of the common garden seeds, I believe there are none which take a shorter time to vegetate than several of the Tetradynamous plants, such as Mustard and Turnip; nor any, I think, a longer time than Parsley. The long torpidity of the last mentioned seed has given rise to a vulgar proverb, in Britain, "that Parsley-seed goes nine times to the Devil, before it comes up."

The seeds of many vegetables take a whole year to vegetate. Such are the Peach, the Almond, the Walnut, the Chesnut, the Peony (Pæonia officinalis,) different species of Canna, or Indian-Reed, and others. Other seeds require two years before they vegetate: such are the Common Dogwood (Cornus florida,) and other species of the genus: the Common Pappaw, or Custard-apple (Annona triloba,) and the Filbert (Corylus avellana.) Some seeds, even under circumstances favourable to their growth, remain a much longer time in the earth before they vegetate. But, with respect to these seeds, the period of their germina-

* "Je ne dirai rien de l'Electricite puisque son influence est au moins douteuse." Physiologie Vegetale, &c. Tom. 3. p. 399.

tion may be greatly advanced by different means, which are familiar to the gardeners. Thus, several of the hard-shelled seeds, particularly the nuts, which require one or more years to vegetate, can be brought to vegetate much earlier, simply by rendering their shells thinner, by a file, or other similar means. The seeds of the Pappaw, which I have already mentioned, may, in this manner, be brought to germinate in a few days. Some writers, however, are of opinion, that this method of treating the harder putamens is not advisable. Mr. Miller advises us to put such seeds between two tiles, with a sufficient quantity of earth, and to place them in a fresh hot-bed, that they may open spontaneously. It is uncertain how long seeds may exist without losing their vegetative property. There are good reasons, however, to believe, that the life of certain kinds of seeds may be protracted far beyond that of any other part of the vegetable, or than the life of any species of animal. It is true, indeed, that the Mosses which have been kept for near two hundred years, in *herbaria* of the botanists, have seemed to revive by the simple process of irrigating them with water.* Perhaps, the Wheel-animal (Rotifer,) which, in this respect, is nearly allied to the Mosses and to seeds, might be preserved for as great a length of time in the sand of tiles and sewers,† where it is not permitted to receive the influence of moisture. But, with respect to seeds, it is certain, that when excluded from the influence of the air, and kept from moisture, they may exist for centuries. The phenomenon, so familiar to Americans, of the successive appearance and growth of different species of timber in the same tract of country, is greatly in favour of this idea. I have little hesitation in supposing, that different kinds of seeds, if imbedded in stone or dry earth, and removed far from the influence of air and moisture, might be made to retain their vegetative quality for a thousand years. But, after all, it is not certain, that this singular immortality, *upon earth*, is the exclusive privilege of the seed. "Life is a property we do not understand."‡ And we never shall understand it, if we attempt to construct systems before we know how or where to collect facts. "Life, however feeble and obscure, is always life; between it and death there is a distance as great as between entity and non-entity."§

I shall terminate these observations on the seed by observing, that in the germination of this egg, the plumule constantly mounts upwards to meet the air, whilst the radicle shoots downward to its mother earth. The mechanical philosophers have attempted an explanation of this sin-

* Speaking of the Mosses Dr. Haller has the following words: "Immortalitatis pene æmulo privilegio hæc eadem folia gaudent; quæ post centenos, & ducentos forte annos, sola in aqua maceratione, in pristinum vigorem restitui possint, quod experimentum in nonnullis C. Bauhini Muscis feci." Alberti v. Haller Historia Stirpium Indigenarum Helvetiæ Inchoata. Tom. III. p. 18. Bernæ: 1768.

† See the wonderful observations of Lewenhoek, Baker, Roffredi, Spallanzani, Fontana, &c. &c. ‡ John Hunter. § Spallanzani.

gular phenomenon. But their ingenuity, as might be expected, has been fruitlessly employed. I am not certain that Dr. Darwin has thrown much light upon the subject. He observes, that "the plumula is stimulated by the air into action, and elongates itself, where it is thus most excited; and the radicle is stimulated by moisture, and elongates itself thus, where it is most excited, whence one of them grows upwards in quest of its adapted object, and the other downward."* But I do not think there is much difference between this species of language, and that of those writers who have ascribed the ascent of the plumule and the descent of the radicle to "a mysterious instinct," or to "a sort of affectation." The time may possibly arrive, when these movements of the embryo in its germinating state, will be deemed instances of "determinate instinct," as much as the first movements of certain species of birds, when they have escaped from their egg; as much so as the instinct which impels the duckling to seek the water, or the chick of the American pheasant (Tetrao Cupido,) to seek the wood, though neither of them have been hatched under females of their own kind.†

VIII.—The Receptaculum,† or Receptacle, is the seventh and last part of the fructification enumerated by L. He defines it, "the base by which the other parts of the fructification are connected." "Basis qua partes fructificationis connectuntur."‡ To this part of the fructification Br. Boerhaave gave the name of *Placenta*, and the ingenious Sebastian Vaillant, that of *Thalamus*. The following species of receptacle are enumerated by L. viz. 1. Receptaculum *Proprium*. 2. *R. commune*. 3. *Umbella*. 4. *Cyma:* and, 5. *Spadix*. In this place I am to speak of only the two first mentioned receptacles. Of the three last, I shall treat under a separate head, viz. that of inflorescence, or the mode of flowering.

A. The *receptaculum proprium*, proper or peculiar receptacle, appertains to one fructification only. Of this kind is the receptacle of all the simple flowers. This species of receptacle has received different names from the particular parts of the fructification which it supports and connects. Thus, 1. The *receptaculum fructificationis*, or receptacle of the fructification, is common both to the flower and the fruit; or, in other words, embraces the corolla and the germ. 2. The *receptaculum floris*, or receptacle of the flower. Here the receptacle supports the parts of the flower only. In these cases, the germen, or seedbud, which is placed below the receptacle of the flower, has a proper

* Phytologia, &c. Sect. IX.

† Mr. Dodart planted, in a pot, six acorns, with the points of their embryos upwards, in as perpendicular a direction as he could. At the end of two months, upon removing the earth, he found that all the radicles had made an angle to reach downward, "as if (to use the words of Father Regnault,) they had been sensible of the botanist's fraud."

† Receptaculum, from *Recipio*, to receive.

‡ Philosophia Botanica, &c. p. 54 §. 86.

base of its own. The last mentioned species of receptacle is denominated

3. *Receptaculum fructus*, or receptacle of the fruit. We have examples of it in Gaura, Oenothera, and others.* 4. *Receptaculum seminum*, or receptacle of the seed. This is the base to which the seeds are fastened, within their enclosure, or pericarp. This species of receptacle is denominated, by some botanists, *placenta*, because it is the common receptacle of the *vasa umbilicalia*, or umbilical vessels, through which nourishment is conveyed to the seeds. It has no definite form except when the common receptacle is absent. It arises often from the receptacle of the fruit, or from the mother pericarp itself.—This species of receptacle assumes a variety of forms, of which it is not my intention to take notice, in this place. I shall content myself with observing, that when it is of a filiform or thread shape, it is called *funiculus umbilicalis*, or the navel-cord. The form of this cord is very frequently that of a slender thread. In the Leguminous plants, however, it resembles a fungous peduncle.† In Date (Phœnix,) and Lontarus, it better deserves the name of a cord, being composed of several fibres, and thicker than a quill. The cord is often simple: but in a few vegetables, it is divided into two branches (rarely into more) at the extremity, nearest to the seed. Of these branches, sometimes only one bears a seed, and the other serves the purpose of a fulcre, as in some species of Vicia and Lathyrus. Sometimes, both of the branches have a proper seed affixed to them, as in Tulip-tree. In Magnolia (and some other plants,) two seeds hang from one individual cord, of a cotton-like substance. By means of the cord, the seed coheres intimately with its pericarp, until the nutritious vessels being closed at maturity, the cord is broken, and the seeds being thus set at liberty, are scattered upon the earth, or other places, from which they draw their future nourishment, in the manner we have seen. B. The *receptaculum commune*, or common receptacle, connects several florets or distinct fructifications, so that if any one of them be removed, an irregularity is occasioned. We have instances of this species of receptacle in the Compound-flowers; and also in the Umbel, Cyme, Spadix, and Rachis, which are afterwards to be mentioned.‡ The receptacle is, 1. *punctatum*, dotted or punctate; sprinkled with the hollow points, or dots: as in Leontodon, Cacalia, Ethulia, Crysanthemum, and others. 2. *pilosum*, hairy; having hairs between the florets, as in Carduus, &c. 3. *paleaceum*, paleaceous or chaffy; the florets being separated by intermediate scales, resembling chaff; as in Teasel (Dipsacus, Scabious (Scabiosa,) &c. 4. *nudum*, naked: neither dotted, hairy nor paleaceous; as in Leontodon, Lactuca, Sonchus, &c. &c. 5. *planum*, flat. *convexum*, convex. 7. *conicum*, conical, columnar; attenuated towards the apex. 8. *subulatum*, subulate. 9. *alveo-*

* See Plate xvi. † See Plate xxi.
‡ See Plates xxiii & xxiv.

latum, alveolate, or honey-combed; divided into open cells, like an honey-comb, with a seed lodged in each cell; as in Cotton-Thistle (Onopordum,) and others. In drawing the generic characters of plants, the receptacle is a part which ought always to be attended to. It is seldom omitted by L. in his *Genera Plantarum*. In discriminating the genera of the class Syngensia, it is a character of very great importance. I have now finished the consideration of all the seven parts of the fructification enumerated by L. I shall conclude the first part of these *Elements* with some account of the *Inflorescentia*, or Inflorscence of vegetables, and the *Calendarium Floræ*.

IX.—By the term Inflorescentia, L. means the various modes in which flowers are fastened to the plant, by means of the peduncle.* That is what Ludwig, and many other botanists have denominated *Modus Florendi*. These modes are thirteen in number, viz. 1. *Spadix*. 2. *Cyma*. 3. *Umbella*. 4. *Spica* 5. *Amentum*. 6. *Strobilus*. 7. *Corymbus*. 8. *Racemus*. 9. *Panicula*. 10. *Thyrsus*. 11. *Fasciculus*. 12. *Capitulum: and* 13. *Verticillus*. The three first of these have already been mentioned under the head of receptacle, but are to be more particularly noticed in this place. 1. The Spadix is the receptacle of the Palms and some other plants, and proceeds from that species of calyx which is called spatha, or spathe. It is either branched *(ramosus,)* as in the Palms, or simple *(simplex,)* as in Indian-Turnip (Arum triphyllum,) Pole-cat-weed, or Skunk-Cabbage (Dracontium, foetidum,) and others. The simple or unbranched spadix admits of some variety. Thus, in Calla, Dracontium, Pothos; and Golden-club (Orontium aquaticum,) the florets cover it on all sides. In Indian-Turnip, they are disposed on the lower parts only, and in Grass-wrack (Zostera marina,) on one side only. According to the number of flowers which it supports, the spadix has received the following names, viz. 1. *uniflorus*, one-flowered. 2. *biflorus*, two flowered. 3. *multiflorus*, many flowered.

2. The Cyma,† or Cyme. This is defined by L. to be an aggregate flower composed of several florets sitting on a receptacle, producing all the primary peduncles from the same point, but having the partial peduncles scattered or irregular; all fastigate, or forming a flat surface at top. We have instances of the cyme in Guelder-Rose or Snow-Ball (Viburnum Opulus,) in Ophiorhiza, and various species of Cornel or Dogwood, such as Cornus sanguinea, Cornus sericea, &c. &c. The cyma is either, 1. *bracteata*, bracteate; furnished with bractes; or, 2. *nuda*, naked; without bractes. Flowers which are disposed in a cyme, are called cymose flowers; *cymosus flos*. In the former editions of

* "Inflorescentia est modus quo flores pedunculo plantæ annectuntur, quem *Modum* Florendi dixere antecessores." Philosophia Botanica, &c. p. 112. § 163.

† Cyma signifies properly a sprout or tender shoot, particularly of the Cabbage. In these senses the term is used by Pliny, and Columella.

L's. *Fragments of a Natural Method*, place was given to an order, *Cymosæ*, consisting of Honey-suckle; Morinda, Loranthus, and a few other genera. In later editions of the work, most of these genera were removed to the order *Aggregatæ*.

3. The Umbella, or Umbel, is a receptacle stretched out into filiform proportioned peduncles from the same centre. I have already given some account of this species of receptacle, or mode of flowering, when treating of the involucrum, or involucre.* Several circumstances, however, respecting the umbel are to be noticed in this place. *a.* The umbel is either, 1. *simplex*, simple, or undivided; as in Ginseng (Panax quinquefolium.) 2. *composita*, compound; each peduncle bearing another little umbel, or umbellule. In this case, the first or larger set of rays, constitute the universal umbel *(umbella universalis;)* while the second or subordinate set of peduncles constitute the partial umbel *(umbella partialis.)* 3. *prolifera*, proliferous, superdecompound, or more than decompound. *b.* The umbella is also, 1. *concava*, concave. 2. *fastigiata*, fastigiate; or rising gradually like the roof of a house. 3. *convexa*, convex. 4. *erecta*, erect. 5. *nutans*, nodding. 6. *terminalis*, terminal. 7. *axillaris*, axillary; and, 8. *oppositifolia* oppositifolious. Flowers which grow in the manner of an umbel, are denominated *Umbellati*, Umbellate, or Umbelled flowers. By many writers they are denominated Umbelliferæ, or Umbelliferous plants.

Umbellatæ is the name of the twenty-second order in L's Fragments: and of the forty-fifth in his natural orders. The greater number of these plants belong to the second order of the fifth class of the sexual system. Ray, Jusseiu, and other writers have called these plants, Umbelliferæ, and Cæsalpinus, *Ferulaceæ*. I shall, in a more proper place, give a list of the principle genera of this great natural family.†

4. The Spica ‡ or Spike; is a species of inflorescence in which sessile flowers, or flowers without peduncles, are (scatteringly) alternate on a common simple peduncle. We have examples of this mode of inflorescence in an ear of Wheat, Rye, or Barley, and many other Grasses; and in Lavender (Lavendula,) Mullein (Verbascum,) Agrimony, and many other plants.

The flowers of a spike are situated immediately upon the stalk, without any partial peduncles, or footstalks, as has already been observed. This circumstance distinguishes the mode of inflorescence of which I am speaking, from the raceme, which is presently to be mentioned. Often, however, in a spike, along with the sessile flowers, we find flowers that are pedunculated; as in some species of Cyperus, &c. The

* See Class v. Pentandria.

† See Class v. Pentandria.

‡ From *spes*, hope; from σπιζω, to extend; or from σπαχυς Æol, for σταχυς, whence *Spicus*, *Spica*, and *Spicum*, "for (as Dr. Martyn observes) it is used in "all the three genders." These terms signify an ear of corn.

spica is, 1. *secunda*,* single-rowed, or one-ranked;† that is, all turned towards one side, or directed or inclined the same way. We have an instance of this in American Cock's foot-grass (Dactylis cynosurioides.) 2. *disticha*, two-ranked or rowed, all the flowers pointing two ways; and, consequently, opposed to secunda. This is instanced in Bog-Rush (Schoenus,) &c. 3. *tetrasticha*, four-ranked. 4. *hexasticha*, six-ranked. The *Spicula*, Spicule, or Spikelet, is a partial spike, or a subdivision of a true spike. This occurs in some of the Grasses, as Darnel, &c. The filiform receptacle which connects the florets longitudinally into a spike, is denominated *Rachis*.‡ "Receptaculum filiform flosculos longitudinaliter annectens in spicam."§ It has received the name of rachis, from its bearing some resemblance, when it is naked or deprived of the florets, to the spine. We have good examples of this species of receptacle in different species of Panic-grass, such as Panicum crus corvi, P. crus galli; in Darnel (Lolium,) and in many other Grasses. 5. Of the Ament and Strobilus I have already taken particular notice, when treating of the various species of calyx,‖ and of pericarp. I shall only observe, in this place, that the ament is more properly referred to the head of inflorescence than that of calyx.¶ 6. The Corymbus, or Corymb,** is said by L. to be "made up of a spike, whilst each flower is furnished with its proper footstalk, or peduncle, in an elevated proportioned situation." L.'s definition is not very intelligible, and hence different botanists have given a different interpretation of the words. In this species of inflorescence, the smaller or partial flower-stalks are produced along the common stalk, on both sides, and although they are of unequal lengths, they rise to the same height, so as to form at the top a flat and even surface. We have examples of this mode of flowering in the following, among other vegetables, viz. Nine-bark or Seven-bark (Spiræa opulifolia,) Scurvy-grass (Cochlearia officinalis,) Gold of Pleasure (Myagrum sativum,) and other Tetradynamous plants. The corymb differs from the umbel in this circumstance, that in the former the numerous partial footstalks take their origin from different parts of the common stalk; whilst in the latter, as we have already seen, all the peduncles proceed from a common centre. The corymb, it has been observed, is a mean between the umbel and the raceme. Like them,

* "We have no proper English term for this. *One-ranked* tends to mislead, because a plant may have more ranks or rows of flowers than one directed to the same point of the horizon, or nearly so." Professor Martyn.

† Darwin.

‡ Ραχις, the back-bone, or spine.

§ Delineatio Plantæ.

‖ See Plate XXVII.

¶ The Strobile gives name to a particular species of spike (*spica strobiliformis*,) or strobile-shaped spike, of which we have an example in Justicia Ecbolium.

** Professor Martyn.

its flowers are furnished with their proper footstalks, which rise gradually from the bottom to the top, as do those of the raceme, and are extended to the same height, as are those of the umbel. The term corymbus is sanctioned by classical authority. Pliny uses it for a cluster of Ivy-berries. "Hederæ racemis in orbem circumactis, qui vocantur corymbi."* Columella puts it for the head of an Artichoke, or Thistle:

"Hæc modo purpureo surgit glomerata corymbo."†

7. Racemus,‡ Raceme, or Cluster, is the name of the eighth species of inflorescence enumerated by L. It is a species of flowering in which the flowers, placed along a common footstalk, are furnished with short proper footstalks, that proceed as lateral branches from the common stalk. The raceme and the spike are nearly allied to each other: for in both, the flowers are placed along a common footstalk, or receptacle; but in the spike, as we have seen, the flowers are sessile, whereas in the raceme they are pedunculated. In general, too, the flowers are less abundant in the spike than in the raceme. But to this there are many exceptions. I have already noticed the essential difference between the raceme and the corymb. The racemus is, 1. *simplex*, simple; or, 2. *compositus*, compound. 3. *unilateralis*, one-sided; having all the flowers growing on one side of the peduncle; as in Serrated Winter-green (Pyrola secunda.) 4. *secunda* all bent or directed the same way. 5. *pedatus*, pedate. 6. *conjugatus*, conjugate. 7. *erectus*, erect. 8. *laxus*, loose. 9. *dependens*, hanging down, and pointing to the ground. 10. *nudus*, naked. 11. *foliatus*, leafy. We have good and familiar examples of the raceme in the Vine, the Currant, the Poke, different species of Prunus, or Plumb, such as the common Wild-Cherry (Prunus virginiana,) &c. In the Latin language, racemus signifies a cluster or bunch of Grapes, Ivy-berries, &c. Thus Pliny: "Hederæ "est minor acinus, sparsior racemus."§

8. Panicula,‖ or Panicle, is the name of the eight species of inflorescence. In this, the flowers or fruits are scattered on peduncles, variously subdivided. In other words, it is a kind of branching or diffused spike, composed of a number of small spikes, which are fixed along a common receptacle or footstalk. We have instances of this form of inflorescence in Oats, Panic-grass, and many other plants. The following are the principal species or varieties of panicula enumerated by the botanists, viz. 1. *panicula congesta*, a heaped panicle; having a great abundance

* Naturalis Historiæ Lib. XVI. cap. XXXIV.

† De Re Rustica, &c. Lib. X. De cultu Hortorum, l. 237.

‡ From ραξ, ραγος, *acinus, racime.*

§ Lib. XVI. cap. XXXIV.

‖ From πανικη, *coma*, a bush or head of hair &c.; or rather from *panus*, the woof about the quill in the shuttle. Pliny, in one place (Lib. XVI cap. XXXVI,) uses this word to designate the down upon reeds.

of flowers. 2. *p. densa*, a dense or close panicle. (This is an higher degree of the above; or, in other words, a panicle which has the flowers both close and abundant.) 3. *p. spicata*, a spiked panicle; approaching in form to a spike; as in Phleum crinitum, and other Grasses, which are, called Spike Grasses. 4. *p. contracta*, a contracted panicle; a greater degree of the foregoing. 5. *p. coarctata*, a squeezed panicle; having the peduncles extremely near to each other. 6. *p. patens*, a spreading panicle; having the peduncles spreading out so as to form an acute angle with the stem. 7. *p. diffusa*, a diffused panicle; having the peduncles spreading out more and more irregularly. 8. *p. divaricata*, a divaricating panicle; spreading out still more, at an obtuse angle with the stem.

9. The Thyrsus,* or Thyrse, is a mode of inflorescence very nearly allied to the panicle, being, in fact, a panicle contracted into an ovate, or egg-shaped form. In the thyrse, the lower footstalks, which are longer, extend horizontally, whilst the upper ones are shorter, and rise up vertically. We have instances of this beautiful species of inflorescence in Lilac (Syringa vulgaris,) in Butter-bur (Tussilago Petasites,) and other plants.

10. The Fasciculus,† or Fascicle, is a species of inflorescence, in which several upright, parallel, fastigiate, approximating flowers, are collected together;‡ as in Sweet William (Dianthus barbatus,) and others.

11. The Capitulum,§ or Head, is that species of inflorescence, in which several flowers form a kind of ball, or head, at the extremity or summits of the footstalk; as in Globe-amaranthus, or Bachelor's Buttons (Gomphrena globosa,) and others. The capitulum is, 1. *globosum*, globular or round; as in Gomphrena globosa. 2. *dimidiatum*, halved; hemispherical, or resembling half a head; as in Lippia hemisphærica. 3. *ovatum*, ovate, or egg-shaped; as in Lippia ovata. 4. *hispidum*, hispid, or bristly; as in Field-Basil (Clinopodium vulgare.) 5. *foliosum*, leafy; intermixed with leaves. 6. *nudum*, naked; having no leaves: of course opposed to the leafy. 7. *pedunculatum*, peduncled, or furnished with little footstalks; as in Teucrium capitatum. 8. *sessile*, sessile; having no short footstalks; as in Teucrium pumilum. 9. *pyramidatum*, pyramidal; shaped like a pyramid; as in Lippia americana. 10. *subrotundum*, subrotund, or roundish; as in Selago fruticosa.

12. The Verticillus‖ is the thirteenth and last species of inflorescence enumerated by L. It is called in English the Whirl or Whorl.¶ It is

* The Greek θυρσος, from θυω, *impetu feror*, *erumpo*, to burst forth.

† Diminutive, from *fascis*, a bundle.

‡ Colligit (says Linnæus) flores erectos, parallelos, fastigiatos, approximatos."

§ *Capitulum*, in Latin, signifies a little head, the top, or chapter of a pillar, &c.

‖ From *verto*, to turn.

¶ It is most commonly written whorl; but whirl seems the more proper orthography; since (as Martyn observes,) it must be derived from the verb *to whirl*, which signifies to turn rapidly.

made up of many subsessile flowers, which surround the stem, in the form of a ring. We have instances of this inflorescence in Penny Royal (Mentha Pulegium,) Horehound (Marrubium vulgare,) Callicarpa americana,* and many other plants. This species of inflorescence, indeed, gives name to an extensive natural family of plants, which are particularly mentioned in the course of this work.† The verticillus is, 1. *sessilis,* sessile, without peduncles. 2. *pedunculatus,* peduncled; with peduncles. 3. *nudus,* naked; without involucre, bracte, or bristle. 4. *bracteatus,* bracted; furnished with bractes. 5. *involucratus,* involucred; furnished with an involucre. 6. *confertus,* crowded. 7. *distans,* distant. 8. *remotus,* remote.

13. I have now given some account of all the various species of inflorescence that are enumerated by L. But I must not close this subject, without observing, that in some plants the flowers grow upon the leaves. This is the case in the genus Ruscus, or Butcher's broom. L. does not designate this species of inflorescence (for such it seems entitled to be called,) by any particular name; but in Ruscus, he calls it "leaf-bearing." A similar mode of flowering occurs in Osyris japonica, a native of Japan. Professor Thunberg, who observed it in this vegetable, speaks of it as a very rare species of structure in the vegetable world.

SECTION IV.

OF THE ANATOMICAL STRUCTURE OF PLANTS.

Plants are organized living bodies, endued with the attribute of irritability. Their organization is by no means simple. Like animals, of various kinds, they are composed of solid and fluid parts. These solid parts, in which it is probable all the living powers of the plant reside, are principally, if not entirely, made up of fibres, the very intimate nature of which is not completely known to us. Whether the living powers of the plant, or, in other words, the life of the plant, be a property distinct from the visible matter which composes it, is a question which we are unable, in the present state of human knowledge, to decide. There are no good reasons, however, to suppose, that the life of plants and that of animals, even of the more perfect animals, is essentially distinct from each other. The vegetable fibres being interwoven together, in a great variety of ways, constitute the membranes, the cellular texture, the receptacles, or reservoirs, and the different species of vessels (both circulating and secretory,) of the plant, which are afterwards to be mentioned. Out of these simple solid parts, are constructed the various organic parts of the plant, such as the root, the stem, and the leaves, some of the fulcres, and the different parts of the fructi-

* See Plate X. Fig. 3.
† See Class xiv. Didynamia.

fication, which have been particularly enumerated and described in the preceding part of this work. Of these organic parts, I proceed to give some account; and for this purpose, I shall make choice of the trunk of a tree, where the different organized parts are most distinctly seen. Nearly the same structure, however, is common to the root, the branches, &c., and the trunk. This is evinced, not only from the evident fabric of the parts, but from the well known fact, which has already been mentioned, "that trees and shrubs, when they are inverted, put forth leaves from the ascending caudex, or proper root; and radicles, or roots, from the ascending caudex or stem." This experiment has often been made with the Willow, and several other trees. The organic substance in the trunks of trees is found to be of various kinds. Six species of such organized substance are enumerated by some of the latest writers* on vegetable physiology. They are the following, viz. 1. *Epidermis, s. Cuticula.* 2. *Cortex.* 3. *Liber.* 4. *Alburnus.* 5. *Lignum;* and, 6. *Medulla.* I shall speak of these in the order in which I have mentioned them.

1. The Epidermis, Cuticula, or Scarf-skin, is the exterior membranaceous covering of the tree.† It is thin, and dry, and generally transparent, and without colour. It does not appear to be a part very complexly organized, but it is, unquestionably, organized. In its substance, we sometimes discover very minute pores, which are supposed to serve the double purpose of absorbing fluids from without, and of exhaling or throwing off other fluids from the vegetables. There can, indeed, be little doubt, that absorbing vessels do arise from the exterior surface of the epidermis, and convey their fluids to other parts of the vegetable. The mouths of these absorbents are some of the pores which have been mentioned. The organic structure of the epidermis is rendered more probable from this circumstance, that when it is destroyed in the living vegetable, it is regenerated again, as is known to be the case with the epidermis of man, and many other animals. The newly formed epidermis is generally observed to cohere more firmly to the bark, than the old or destroyed covering.

Many writers have considered the epidermis as a simple integument; but it is very probable, that in all vegetables, it is composed of different layers, though these, by reason of their extreme tenuity, may readily elude the observation of our senses. Duhamel has shown that the epidermis of the Birch-tree is composed of several layers, of which he was able to count six. In the Paper-Birch (Betula papyrifera?) I have often counted at least twice this number of distinct epidermidal coats. In the Seven-bark or Nine-bark (Spiræa opulifolia,) the epidermis is, likewise, found to consist of several layers. Hence, the common names, which I have just mentioned, of this shrub, in the United States.

The epidermis serves to defend the bark from the injuries of the air. By its callous structure, it appears to be well fitted to keep open the

* Plenck, &c. † "*Epidermis* tunica exterior plantæ sicca tenuissima."

absorbing orifices which terminate upon its surface. It is also highly probable, that this integument is of essential use by preventing an excess of evaporation from the parts which it covers. Indeed, actual experiments have shown, that from a given surface of the bark of a tree deprived of its epidermical coverings, there was a much greater evaporation, than from the bark over which those coverings were suffered to remain. Moreover, it is ascertained, that the epidermis of the trunk and branches of several vegetables is absolutely impermeable to water. In many vegetables, however, there is reason to believe, that the case is otherwise.

2. The cortex,* or Outer-Bark, is the second integument or covering of the vegetable. It is plated, lax, dry, and hard, and often in chinks.† It seldom adheres very firmly to the third integument, or liber, but the degrees of its adhesion are various. In the herbaceous plants, the part corresponding to the cortex is called *Cutis*, or the Skin. In these, it is of a much softer texture than in the trees properly so called. The cortical plates, or layers, appear, from the latest observations of the botanists, to be formed of a net of longitudinal fibres, which wind more or less round the axis of the vegetable, and compose meshes of a larger or smaller size. The fibrous structure is very readily perceived when the bark is macerated in water, for by such maceration we destroy the cellular substance which separates the fibres. Each of these more conspicuous fibres is composed of several others, which are much more minute, and which cannot readily be discovered, without the assistance of good glasses. These fasciculi or bundles of fibres are not solated, or entirely detached from each other. They are often connected to each other by certain portions of the vegetable, which throw themselves off from them, and incline towards other bundles, accompany them in their inflections, and combine to form other bundles. In this manner a large net-work is formed, the interstices of which are filled up with parenchymatous matter, as in the leaf of which we have already treated. Now the bark is composed of a number of such nets placed over, and contiguous to, each other. This structure is beautifully conspicuous in Daphne Lagetto‡ of the West-Indies. The interior bark of this vegetable is composed of twelve tunics or layers, which being extended and cleared from the cuticle, expose to view a fine net-work, of which neck-cloths, aprons, and other similar articles are made. The net works, which I have mentioned, are not all perfectly similar to each other, either in the same or in different vegetables. On the contrary, a considerable variety in the net-works has been observed in those vegetables which have, hitherto, been particularly examined. The larger fibres composing the meshes of the net-work, are

* From *corium*, a hide, and *tego* to cover.

† "*cortex* secundum integumentum plantæ, laminosum, laxum, siccum, durius, sæpe rimosum."

‡ Lagetta of Jussieu. Bois dentelle, or Lace-wood, of the French.

supposed to be the vessels which conduct the sap into the utricles, the vessicules and small vessels of the parenchyma, in order to receive its final preparation. In this parenchymatous structure, it is supposed, by Senebier and other late writers, that the sap is combined with the carbon, which is here precipitated, by the action of light, from the carbonic acid or fixed air. Of the bark, as well as the epidermis, I have already given some account, when treating of the anatomical structure of the leaf. Other circumstances relative to the fabric of the bark, and to the importance of this part of the vegetable, will afterwards claim our attention.

3. The Liber,* or Inner-Bark, is the third integument discoverable in the trunk of trees. It is more membranaceous, juicy, and flexible, than the outer-bark, and may often be separated from the bark and from the blea.† This integument has received the name of liber from its fine and thin plates, which are thought to bear some resemblance to the leaves of a book. Or it is more probable, that the Latin word *liber* took its name from this portion of the bark; in like manner as the English word book (from the Saxon *boc*,) may, perhaps, be ultimately traced to the word *Pak*, or *Pauk*, which in the language of certain Asiatic tribes, such as the Curdes, signifies the leaf (folium) of a vegetable. This will appear the less improbable, when it is recollected, how much it is the practice of some nations to change the P into B, and the latter into the former; a practice particularly observed among the American Indians, and from a want of attention to which, it has often been supposed that their languages, which are really *closely-allied* dialects, are *radically* different from each other.

The liber is the last layer of the bark, or that nearest to the wood. Like the bark itself, it is composed of a number of concentric networks, placed one over the other. This part of the vegetable varies in regard to its appearance and quantity, in different vegetables. In the Lime or Linden-tree (Tilia) it is not very different from the wood. In general, it is more abundant in vigorous trees, than in those which are less vigorous, of the same species. In the spring-season, it is more easily separated from the bark than at other times. At this time, also, it is more tender. When, in the progress of the season, it has acquired its peculiar or adult hardness, it forms the wood. In the ligneous or woody plants, it is not a difficult matter to fix upon the precise situation of the liber, in regard to the exterior bark and the blea, or the wood. Wounds in the bark heal more or less readily; the two lips or edges of the wound uniting together. In short, there is here a renovation of the bark. But the healing of a wound in the liber is essentially different from this; for here the wound forms a round edge, the two lips not uniting together. The liber, as we shall afterwards see, always finishes

* Profesor Martyn thinks the most probable derivation of this word is "from the Æolic λειπος for λεπος, which by changing π into β became γεβηρις."
† "Tegmentum tertium membranaceum succidum flexile."

where the alburnum, or blea, begins. There is every reason to believe, that the complete developement of the liber forms the wood. The liber, like the wood, contains a great number of the vessels called *tracheæ*; but the exterior bark (cortex) contains very few, if any, of these vessels. The liber, is, unquestionably, the most important portion of the bark. This is evident not only from its annual conversion into wood; but also, from the injury which trees receive, when they have been deprived of their liber. The mere destruction of the bark is, indeed a source of great injury to trees. Nevertheless, many vegetables continue to live and flourish after very considerable portions of their exterior bark have been destroyed. This is said to be particularly the case in regard to the Apple-tree, the barking of which is found not only not to destroy the tree, but even to increase the chances of its life and vigor. But the destruction of the liber is always found to be highly injurious, and even generally fatal, to the tree. This is especially the case, when, along with the liber, we remove the blea. Trees, rarely, if ever, recover, when these two parts have been destroyed in the same individual. Hence, the efficacy of the practice of *girdling* as it is called, in the United States. When the farmer wishes to cultivate a piece of ground that is covered with timber, the shade of which would be injurious to his grain or other vegetables,* and if he does not find it convenient to cut down the trees, he proceeds to *girdle* them. This operation is performed by making with an axe, one or more complete circles through the bark and the liber of the trunk of the tree, and cutting some distance into the blea. Trees rarely survive this operation, especially if it have been performed early in the spring, before the first flow of the sap from the root towards the extremities. It is not uncommon, indeed, to observe trees, in foliage, though they have been girdled; but such trees very seldom live more than one year after the operation. It is proper, however, to observe, that different trees differ very greatly in regard to the duration of their life; after having been wounded, in the manner I have mentioned. In other words, some trees are very readily killed by girdling; whilst others survive this operation for a considerable time. Among the more hardy trees, or those which it is more difficult to kill by girdling, I may mention the Sugar-Maple (Acer saccharinum,) and the Common Sour-Gum (Nyssa integrifolia.) The Pines, in general, are readily destroyed; when they have been girdled.

During the winter-season, the liber acquires neither firmness nor thickness; because, during this season, the business of vegetation is, in a great degree, suspended. This observation, however, must be understood to apply to those climates only which have a severe winter. The liber, in some vegetables, is found to be the seat of certain properties,

* I know but two North American trees, the shade of which is not injurious to vegetation. These are the Persimmon (Diospyros virginiana,) and the Common-Locust (Robinia Pseud-acacia.) It is at least certain that the shade of these is much less injurious than that of other trees.

which are not observable in any other part of the vegetable structure. Thus, the aromatic property of the Cinnamon-tree (Laurus Cinnamomum,) seems to reside entirely in this portion of the vegetable fabric. In like manner, the colouring principle of many vegetables is entirely, or principally, seated in the liber. This is the case in the Quercus tinctoria,* and various specimens of Walnut and Hickory (Juglans,) not to mention others.

4. Immediately under the liber, or inner bark, we find, in many vegetables, particularly trees and shrubs, a peculiar substance, to which L. has given the classical name of Alburnum: the "mollis ac pessima pars ligni," as Pliny calls it.† L. defines it "the intermediate substance of the inner bark and the wood:" "intermedia substantia libri & ligni.‡"

The Alburnum, which many English writers denominate the Blea, but which is better known in Britain and in the United States by the name of the "Sap," is the more soft and imperfect wood, which is generally of a whiter colour than the other wood, from which circumstance it has received its name of alburnum, or alburnus. By reason of its colour and its comparative softness, it has also been denominated the fat of trees, *adeps arborum.* The French call this part of the substance of the vegetable, *Aubier.* In general, the sap is most conspicuous in those trees which have a very hard wood, such as the Oak and the Elm. It is, however, sufficiently conspicuous in other trees, the wood of which is more soft, such as the Tulip-tree (Liriodendron,) the Pines (Pinus,) Red-cedar (Juniperus virginiana,) Lime-tree, and others. The sap, in the greater number of trees, is of a whiter colour and of an harder texture than the bark. It is found to contain lymphatic vessels, cellular matter, proper vessels, and utricles; but these are in general, less perceptible in the sap than in the bark. The sap marks the disappearance of the bark, and the commencement of the newly formed wood. When we cut a branch of an old tree, in the season of the running of the sap, we observe the vessels of the blea full of juice, discharging the contents at the cut.§ The sap may be distinguished from the wood by attending to the following circumstances. It has less density than the wood, its colour is brighter than that of the wood. It is less abundant in resinous matter, but more abundant in water, than the wood. The organization, however, of these two parts of the vegetable fabric is very similar, though the vessels of the sap are more distinct, and its tracheæ less remarkable, than those of the wood.‖ Authors differ greatly in opinion concerning the formation of the blea. L. imagined it was formed by the bark. But it is certain that the whole of the bark does not give birth to the blea, and Duhamel, and

* Dier's-Oak: commonly called Black-Oak, and Red-Oak.

† Lib. xvi. cap. xxxviii.

‡ Philosophia Botanica, &c.

§ Senebier. ‖ Senebier.

other writers have proved, that the cortical beds never change into wood. It is the opinion of Mr. Senebier and some other modern writers, that the blea is the developement of the woody fibres existing in the state of a mucilage, before they are perceptible to us; or, in other words, that it is the developement of a pre-existing part of the vegetable. These fibres, which are supposed to be enclosed in the seed, are changed, by little and little, until they are metamorphosed into blea, and from this changed into wood.

5. The Lignum, or Wood, is defined by L. "the liber, or inner bark of the preceding year, deprived of its juice, hardened, and glued fast together:" "liber præcedentis anni, nunc exsuccus, induratus, agglutinatus."* The wood is better defined by Lamarck, that part of the trunk which is perfectly woody, and situated under the liber: it is a compact and firm mass of fibres and vessels produced by the continual pressure of the blea, and constitutes the strength and support of trees. In the annual and biennial vegetables, the substance which answers to the lignum is called, *carnea substantia*, or the fleshy part. When we make a transverse section of a stem or branch of a tree, we readily distinguish the woody portion. It differs from the cortex and the pith by its colour. It is harder than either of these parts. Its density is much greater. Nor is its organization precisely the same, as we shall presently see. The wood, as well as the bark and the blea, is composed of a number of concentric layers, or beds, which are laid over one another, somewhat in the same manner of the coats of an Onion. These layers differ greatly from one another in regard to their hardness, their density and their colour. In different species of vegetables, and even in the same species of different seasons, they are more or less firmly attached to each other. It is also observed, that the layers are of a more lax texture on the south than on other sides of the tree; and that they are often considerably broader on the south than on the north side. The ligneous circles in the trunks of trees are commonly disposed in an eccentric manner; that is the centre of the circles is placed at a distance from the centre of the tree. This eccentricity has been ascribed by Mr. Duhamel to the casual insertion of roots, and to the irruption of branches, which determines the sap to move more abundantly on one side of the tree than on another. This, it is highly probable, is sometimes the case. "But (to use the words of the learned Professor Walker) when the centre of these circles stands nearer the north than the south side of the tree, and the circles themselves on the south side are considerably broader than those on the north, which is usually the case, the eccentricity is to be ascribed to a different and more general cause. For as there is a more copious flow of the sap on the south than on the north side of trees, owing to the one being more in the sun, and the other in the shade, this must naturally affect the shape of their trunks; the sap on the south side being more

* Philosophia Botanica, &c.

plentiful, there the growth of the wood must, of course be more considerable."* The layers which I have mentioned, are not to be considered as simple or indivisible. On the contrary, when a piece of the wood of an Oak or other tree has been macerated, for some time, in water, we readily discover by the assistance of glasses, that each layer may be divided into other smaller layers, and these again into still smaller. In many trees, during the season of the ascent of the sap, the various beds are much more distinctly seen than at other times, because they now subsist in a loose and unconnected state. This should teach us the propriety of avoiding the cutting down of timber, when we wish to employ it, for purposes of duration, during the running of the sap.†

Originally, the ligneous beds are soft and tender, and acquire their solidity, only in a gradual manner. These beds are disposed in concentric circles or rings, the exterior ones, or those immediately next to the bark, being of a posterior formation are softer and less coloured than those that are situated nearer to the centre. The principal body of the wood is made up of these interior beds or layers. The outer beds form the alburnum, which has already been noticed, and out of which the woody structure, however hard or firm, is annually formed. It is commonly supposed that one of the principal more conspicuous layers or circles, of wood, is added every year.‡ There can, indeed, be little doubt, that this is the case; and thus, by an attention to the number of the circles, we are enabled to form a pretty certain judgment of the age of the tree. Proceeding upon this ground, trees have been examined, the age of which could not have been less than five hundred years. In a chronological point of view, an attention to the thickness and the number of the ligneous circles of a tree may be rendered a matter of much curiosity and importance. In an Oak which L. examined in the island of Eland, in the Baltic-Sea, he was enabled to point out the ligneous circles which had been formed during the several severe winters of 1578, 1687, and 1709.§ By carefully counting the number of circles of some of the trees which were growing upon the extensive earthen fortifications at the confluence of the rivers Ohio and Muskingum, it has been determined, that the age of those ancient works was not less than four hundred years: or, rather, it was

* See Experiments on the motion of the sap in trees, By John Walker, D. D. M. D. &c. in Transactions of the Royal Society of Edinburgh. Vol. 1. Part ii. pages 12 & 13.

† During the period of the ascent of the sap, all the different strata of the vegetable are observed to be more separate than at other times. The epidermis separates from the bark; the bark from the liber; the liber from the blea; this from the wood; and the circles of wood, as we have seen, from one another.

‡ Reichardt (in his *Gartenschacz*) denies that the ligneous rings ascertain the annual increment of the tree.

§ These circles were thinner than the others.

ascertained, that at least, four hundred years had elapsed since those works had fallen into ruins.

The wood, like the bark, is composed of fibres and of vessels. These form a species of net-work; the meshes of which are filled with parenchymatous matter. These fibres and vessels are not essentially different from those of the bark. Of the vessels of the wood, those which are the most numerous are called lymphatic vessels. Uniting with these, we find another system, or set of vessels, which are denominated proper vessels *(vasa propria.)* When we make transverse sections of the Fig tree, and many other vegetables, we readily observe juices to flow from these vessels. It is evident, from the discharge which takes place, that these vessels are disposed in an annular manner or direction. The proper vessels of the wood differ from those of the bark in regard to size. In the wood, they are not so large as in the bark. Moreover, the vessels of the wood are disposed in bundles, and form nets placed one over another. The tracheae are thought to be peculiar to the woody structure. It is certain, however, that they exist abundantly in the leaves, in some of the fulcres (such as the stipules, bractes, &c.) and in the petals of plants. But in all these it is supposed that they are entirely confined to the ligneous threads or portions of wood, which constitute a part of the leaves, fulcres, and petals. Lewenhoek, a long time ago, discovered tracheae in the tender part of those branches which ultimately changes into wood. Duhamel could not discover them in the wood. If it be true, that tracheae do not exist in the bark, we are necessarily led to believe, with Senebier and other writers, that this system of vessels is only to be found in that part of the liber, which is to become wood. Upon the whole, it appears that the wood of vegetables is formed by the union of the fibres, the lymphatic vessels, the proper vessels, and the tracheae, together with parenchymatous matter. Beside these, there exist in the wood resinous and other matters; which are more or less abundant in particular vegetables. The principal of these matters is a resinous substance, which, in many vegetables, serves to give a degree of compactness to the ligneous structure.

6. The Medulla, or medullary part of the vegetable, next claims our attention. This is well known by the English names of Marrow, or Pith. In French it is called *moelle,* or *moile.* It is thus defined by L. "substantia intima vesiculosa; internumve parietem trunci cavi obducens:" That is, "the inner vesicular substance, or that which clothes the inner surface of a hollow trunk." Lamarck defines the pith "a part or an organ essential to the life of the plant, placed in the centre of the woody body; and composed of very loose vessels, and of utricles." In the new productions of trees, the pith is found to consist of a number of oval, green, and succulent bladders, which are very similar to those of the bark and wood. At the expiration of one or two years, more or less, these bladders become empty, exsiccate, assume a spherical shape, and finally take the consistence and the color of pith,

which, in the greater number of vegetables, is of a white or cream colour. In some vegetables, however, it is of a yellow or rust-colour. This is the case in the Horse-Chesnut (Æsculus Hippocastanum:) in others again, it is brown, as in Walnut; and in Barberry, it is yellow or inclining to a yellow. It is in the heart as it were of those vegetables which abound in the pith, that this substance is principally found. In these vegetables, it is contained in a kind of tube, which serves to diffuse it into the substance of the wood and bark. In general, herbs and shrubs have a greater proportion of pith than trees. In the Elm, the Oak, the Hazel, the Pear and Apple-trees, hardly any pithy substance is to be found. The quantity of it is inconsiderable in Walnut, Holly, Ash and Pine. It is entirely wanting in Guaiacum (Guaiacum officinale,) Ebony, and in the roots of Tobacco and Thorn-apple. The vegetables which have the greatest quantity of pith are the Elder; the Hawthorn, the Fig-tree; the Sumach (Rhus glabrum and R. typhinum,) Catalpa (Bignonia Catalpa,) and Creeper, (Bignonia radicans.) In general, however, the pith bears a kind of proportion to the age of the vegetable; that is, it is more abundant in young than in old vegetables, and in the younger than in the older branches of the same vegetable. Though the pith, by reason of its soft and spongy texture, seems so well calculated to imbibe fluids of different kinds, yet actual experiments have shown, that fluids, which are readily absorbed by the bark and wood, can never be made to enter the pith. This point is unanimously conceded to by Baisse, Bonnet, Reichel, Walker and other writers, who have particularly turned their attention to this subject. Mr. Du Hamel, however, imagines, that the pith is furnished with both *vaisseaux propres*, or proper vessels, and *vaisseaux lymphatiques*, lymphatic vessels, or vessels which convey the sap. In the many experiments which I have made with a view to trace the progress of absorbed fluids in vegetables, I have never yet met with an instance in which I could discover the pith in the least coloured. In making these experiments, I have principally confined myself to a diluted ink, and to the colouring matter of the berries of the Phytolacca, or Poke. By these fluids, particularly the latter, I have seen the channel between the bark and the wood, very distinctly coloured, the whole substance of the wood itself also colored, and the very edges of the pith. But the pith itself was never coloured. I am far, however, from asserting, that the pith is entirely destitute of vessels. On the contrary I think it more probable, that, like the other parts of the vegetable structure, it is supplied with its peculiar vessels. They may have escaped our observation, as being more minute and delicately formed than the vessels of the other parts. Professor Batsch, of Jena, calls the pith-vessels, *vasa medullaria*. L. imagined, that the pith draws its nourishmemt from the bark. But physiologists are not satisfied with the arguments which the Sweedish naturalist has adduced in favour of this opinion. On the contrary, the experiments of Dr. Walker rather favor the opinion, that the pith is supported by the

wood, "because during, the whole spring season, the wood was replete with sap, while the bark was dry. Besides, when the trunk of a tree, for a certain space, is decorticated quite round, the pith, in the decorticated part lives, and all the parts of the tree above it, so long as the wood continues green, and conveys sap which it will do for years."* Authors differ in opinion concerning the use of the pith. L seems to have supposed, that the principal use of this part is to give birth to the buds:† an opinion, which as we shall afterwards see is countenanced by many facts. Sir John Hill warmly attacked L's. idea of the importance of the pith. He asserts, that, in many instances, the pith is by no means, uniformly continued, but divided by partitions, and completely invested with a membrane, to which the English botanists gave the name of the *corona*, or crown. Whatever merit may be attached to Hill's experiments and observations, it is certain, that many experiments most incontestibly prove, that the pith of vegetables is of much less importance in the economy of the vegetable than L. imagined. We frequently observe trees of different kinds, particularly Willow-trees, the trunks of which are entirely destitute of the pith and even of the wood, which in fact consist of mere bark, and are, nevertheless, in a living and pretty flourishing state. Nay, we find buds on the surface of the bark thus deprived of its pith. Besides, we know well that if a branch of Willow be entirely deprived of its pith, and fixed in the ground, it will live and grow, and throw out new branches. Dr. Walker is of opinion, "that the pith has little or no share in supporting the wood; the bark or the general vegetation of the tree, and that its principal use is to aid the formation of the fruit." Many experiments render this theory not a little plausible. The buds of vegetables are pretty constantly found to be connected with and even rooted in the pith, by means of the *diametral insertions*, or those radiated lines of the wood, which extend from the pith to the bark. Moreover, it is certain, that we seldom observe buds upon a tree, without being able to detect their connection with the pith; and, lastly, buds are almost always most abundant, where the pith is most copious.

It is the opinion of L. that the preceding parts of the vegetable structure exclusively form some of the individual organs of the fructification, which have already been described. Thus according to this naturalist, the cortex, or outer bark forms the calyx; the liber, or inner bark, the petals; the lignum, or wood, the stamens; and the medulla, or pith, the seed. L's. peculiar notions on this subject have been implicitly received by many naturalists. Nor ought this to excite our wonder, when it is recollected, how greatly particular parts of the idea are supported by facts.

We have already seen that Mr. De Jussieu admits the doctrine of the

* Experiments, &c. pages 38 & 39.

† Philosophia Botanica, p. 37. §. 79.

origin of the calyx from the outer bark, and that of the corolla from the inner bark. Facts which have been mentioned greatly countenance the idea of the origin of the germ from the pith. This latter idea has received much additional weight of illustration from a memoir by the late learned Mr. L'Heritier. The theory of L. however, with respect to the anatomical structure of the fructification, should not be hastily received. It seems, upon the whole more probable, that several different parts of the vegetable structure contribute to form the individual organs of the flower and the fruit. Dr. Hedwig has ably controverted the opinion, that the outer bark gives origin to the calyx, and the inner bark to the corolla. Dr. Grew had, a long time before, asserted, that the calyx ("empalement,") "whether of one or more species," is "compounded of the three general parts, the skin, the cortical and ligneous bodies: as is evident (says this learned naturalist) from the Artichoke, in which the continuation of all these parts is clearly discoverable; the empalers being of that amplitude, as fairly to shew them all."*

SECTION V.—OF THE VESSELS OF PLANTS.

Plants, like all other organized bodies, are furnished with a vascular system, or system of vessels. These according to L. are of three kinds: viz. 1. Succiferous or Sap-vessels, which are destined to convey the juices of the plant. 2. Air-vessels *(Tracheæ,)* for receiving and for distributing air. 3. Utricles *(utriculi,)* or small bladders, containing various kinds of secreted fluids. Since the time of L. however, our knowledge of the vessels of vegetables has been considerably enlarged, though it is to be regretted, that the subject is still involved in great darkness. The following are the principal species of vessels which the later vegetable physiologists have attributed to plants. I. Sap-vessels. II. Proper-vessels. III. Air-vessels. IV. Medullary-vessels. V. Absorbent vessels. VI. Excretory vessels: and, VII. Secretory vessels.

1. The Sap-vessels are those vessels by which the sap or common juice (*succus communis*) is conveyed from the root to most other parts of the plant. These vessels are very small, and are supposed by many writers, to be entirely destitute of ramifications. They are disposed in a longitudinal direction, and circularly, or in rings, in the vegetable structure. They are found in different parts of the plant, but particularly between the bark and the wood, and in the wood itself. No experiments have hitherto detected them in the pith, though Mr. Du Hamel, as has already been observed, imagined, that they exist in this portion of the vegetable structure. By L. and other writers, these vessels have been named *vasa succosa.* The French call them *vaisseaux seveux*, ou *lymphatique.* The sap vessels have been subdivided into arterial *(vasa succosa, arteriosa,)* and venous *(vasa succosa, veno-*

* The Anatomy of Plants, &c. p. 35.

sa.) The former are more exterior, or situated nearer to the exterior coverings of the vegetable; and are also more firm and tenacious in their structure. The latter are more numerous, and tender, and are situated in the cellular texture of the vegetable. The motion of the sap is a phenomenon which has excited much of the attention of philosophers, within the last one hundred and fifty years. The subject, however, is still involved in great uncertainty. We know indeed with sufficient certainty, that the sap is conveyed from the root to most other parts of the plant. But it still remains to be discovered, whether the sap again returns to the root, by the same, or by another system of vessels. The sap moves through the bark, the wood, and between the bark and the wood. The last is its favorite channel.

II. The proper vessels are larger than the sap-vessels, and are not so numerous. These contain the proper juice, or vegetable blood, which differs very greatly in different plants. Thus, it is lacteous or milky in the spurge (Euphorbia,) and in many of the plants of the natural order Contortæ, such as Asclepias, Apocynum, Nerium, &c. It is yellow or orange-coloured, in Celandine (Chelidonium,) in Puccoon (Sanguinaria canadensis,) and many others. It is red in Patience-Dock (Rumex Patientia,) green in the Periwinkle (Vinca,) and in Phallus impudicus. The substance of the proper juice is gummy in the Cherry and Plumb, and peach: it is resinous in the Pine, in the Fir, and many other Coniferous vegetables. The proper juice differs very essentially from the common juice. It is commonly endued with a powerful smell or taste, and exerts decided effects upon the animal system. The sap or lymph, on the contrary, is destitute of smell and taste, and is nearly inert with respect to the body. Owing to the great variety of this juice in regard to colour and substance, it is denominated the proper juice *(succus proprius,)* because each species of plant has been supposed to contain a fluid, which is peculiar or proper to it. This, however, is not strictly the case. On the contrary the proper juices of different species of plants (and in some instances, of the species of distinct genera) are so similar, that they cannot be distinguished from each other.

III. The Air-vessels, or Tracheæ, as they are more frequently called, are of a larger diameter than either of the preceding systems of vessels. These vessels are formed of thin and narrow plates, and are twisted in a spiral manner.* They are found in the wood, in the blea, and in the leaves. In these latter organs, and in the stems of many plants, such as those of the Nymphæa Nelumbo of L. they may be easily seen by breaking the parts, and gently pulling those parts asunder. The tracheæ were formerly supposed to contain air only, and hence they received their name which, in the bodies of animals, is ap-

* Mr. Duhamel justly observes, that one may form a pretty correct idea of the tracheæ, by viewing a ribband rolled round a little cylinder. For a figure of these vessels, see Darwin's *Phytologia*, Plate ii.

plied exclusively to those vessels which convey air. It has, however, been satisfactorily demonstrated by the more correct observations of Reichel, Hedwig, and other writers, that the tracheæ carry certain juices, as well as air. And hence, they have been denominated Pneumato-chymiferous vessels *(vasa Pneumato-chymifera.)* By the French they are called *vasseaux aerophores,* ou *trachees.* Dr. Darwin is of opinion, that they "constitute the absorbent vessels of the adult vegetable, and the umbilical ones of the embryon bud." He remarks, that "they have been erroneously believed to be air vessels," which (he thinks) they cannot be, because "they exist equally in the roots of plants, as in their barks, and have no communication with the horizontal perforations of the cuticle of the bark." This ingenious writer also observes, that the tracheæ "of the trunks of trees or herbaceous plants may be thought to resemble the receptaculum chyli of animal bodies."* In the preceding pages, I have had frequent occasion to make mention of the tracheæ. It was observed that "they are thought to be peculiar to the woody structure." We have seen, however, that they abound in the leaves; in the petiole, in the peduncle, in the petals, and in other parts. But it has been conjectured, that they reside exclusively in the ligneous threads, which enter into the structure of these parts. This is a point which is not yet satisfactorily determined. I am inclined to think, that the tracheæ do exist in the bark, though their existence has not yet been decidedly demonstrated by any writer. If, as Darwin conjectures, they be the real absorbents, it would seem that they pervade almost every part of the vegetable structure.

IV. The medullary vessels *(Vasa medullaria)* are the cells which constitute the medulla, or pith, of which I have already treated. They do not appear to be very properly named vessels. They are less numerous than the preceding system of vessels. They are never observed to be collected together in bundles. In the Elder and other plants, they are found to pass off horizontally from the centre to the cirumference of the plant, like diverging rays. But the ingenious Mr. Defontaines has shown that in the monocotyledonous plants, such as the Rushes, Asparagus, and others, the medullary vessels do not form diverging rays. In these plants, the medullary matter is much more abundant, and completely envelopes the ligneous fibres, which are not formed in concentric layers, but are distributed without order, and are more distant from each other nearer to the centre of the plant than towards the circumference.

V. The absorbent vessels are very numerous in the radicles of plants, and on the surface of their leaves. It is highly probable, that every part of the plant, both external and internal, is supplied with them. Their office seems to be to absorb or take up water, gases of different kinds, earth, carbone, and whatever else constitutes the food of plants. They also absorb various kinds of colouring matters, and

* Phytologia, &c. Sect. II.

even metallic salts. Dr. Darwin, as we have already seen, is of opinion that the tracheæ, or spiral vessels, are absorbents. This idea, which many facts contribute to render plausible, deserves a more careful investigation.

VI. Excretory vessels. The learned Dr. Hales has very satisfactorily demonstrated the existence of this system of vessels upon the surface of the trunk, branches, leaves and flowers of vegetables. This celebrated naturalist found, that a very considerable part of the moisture which has been absorbed by the roots of vegetables, passes off by perspiration. The more recent experiments of Priestley, Ingenhousz, Senebier, and other able experimenters, have been, by many writers, thought to show, that oxygenous gas or vital air, is excreted from the leaves of plants. This doctrine, however, has, of late, been ingeniously controverted by Professor Woodhouse,* Mr. Ellis, and other chemists and botanists. It has also been said that excretions, of different kinds, take place, during the night, from the roots of plants. It is, indeed, highly probable, from what has already been said, that some of the radicles, as they are generally denominated, of the bulbous and other roots, are exhaling rather than absorbing vessels. The observations of Professor Brugmans, of Leyden, render it probable, that the liquids which are exhaled from the roots of some plants are very injurious to other plants, which grow near to them. In this way, the Wheat is thought to be injured by the Blue Erigeron, or Fleabane (Erigeron acre;) Oats by the Corn-Saw-wort, or Way-thistle (Serratula arvensis,) and the Carrot (Daucus Carota) by the Elecampane (Inula Helenium.) Mr. Brugmans carefully examined the roots of some plants, which had been injured by Darnel. These roots assumed the appearance of having been preyed upon by an insect. With the view to determine, whether the appearance in question was owing to the Darnel, the Professor placed this plant and another in a glass vessel. Upon examining the plant, he found its roots affected, as in the former instance. He, therefore, thought himself authorized to infer, that the injury had been occasioned by the influence of some active fluid, excreted, or emitted, from the radicles of the Darnel.

It is much to be wished, that a subject so curious and important as this were pursued, in a train of carefully conducted experiments. The results could not but prove highly interesting in an agricultural point of view.

VII. Secretory vessels. The existence of secretory vessels in plants cannot be doubted, although our knowledge of this system is far from being complete. The office of these vessels is to secrete fluids of different kinds, which are useful in the economy of the vegetable. They are generally supposed to be accompanied by a glandular apparatus. In the vegetable, however, as well as in the animal, we often find

* See Mr. Nicholson's Journal of Natural Philosophy, Chemistry, and the Arts. Vol. ii. For July, 1802.

peculiar (and probably secreted) fluids, although the existence of the glandular structure has not been detected. The honied fluid which is found in the true nectaries, as in those of the beautiful Canadian Columbine (Aquilegia canadensis,*) and many other plants, and also in the tubes of many monopetalous corollas, such as that of Jamestown-weed (Datura Stramonium,) is, in all probability, secreted by a peculiar action of the vessels of the parts. This action whatever may be its precise nature, is evidently and greatly influenced in the plant, as well as in the animal, by the *incitant* power of various agents, such as camphor, nitre, &c.—The anthers have been considered as glands, destined to secrete the pollen, or fecundating powder. But these are points still involved in great uncertainty. Much, indeed, remains to be done before the structure, and offices of the various systems of vessels in plants can be completed. A rich and ample field is opened for the labours of some future, happy experimenter.

SECTION VI.—OF THE GENERATION OF PLANTS.

In the first part of this work, I have given a description sufficiently minute, of the organs denominated by L. and his followers, the Stamens and Pistils. I have also hinted at the functions of these organs: but the subject is now to claim a larger share of my attention. According to L. the stamens and pistils are the male and female organs of generation: those parts, in other words, which this naturalist deems necessary, *so far as sexual intercourse is concerned*, in perpetuating the species of plants. I say this naturalist, without meaning to insinuate, that the doctrine of the sexes of plants, as depending upon the stamens and the pistils, originated with L. for this is what no one now asserts; and although it might be shown, that we even owe much less to the Swedish naturalist, as an investigator of the beautiful truths of the doctrine, than many naturalists seem to imagine.†

* See the Plate.

† "The real use of the Stamens of Plants, says Dr. Smith, was long a subject of dispute among philosophers, till L. according to the general opinion at present, explained it beyond a possibility of doubt." Again, "L. towards the year 1732, reviewed all that had been done before him, and clearly established the fact so long in dispute, in his *Fundamenta* and *Philosophia Botanica*. He determined the functions of the Stamens and Pistils, proved those organs to be essential to every plant, and thence conceived the happy idea of using them for the purpose of systematical arrangement. In the latter point (adds Dr. Smith) his merit was altogether original; in the former, he made use of the discoveries and remarks of others, but set them in so new and clear a light as in a manner to render them his own." *An Introduction*, &c. p. 312, 315.

But my object, at present is to discuss the outlines of the sexual doctrine, without particularly inquiring into its antiquity, and without endeavoring to assign to each of the many writers who have written more or less extensively upon this interesting subject, the actual share of merit which belongs to each, as discoverers or elucidators of facts. In an history of the sexual doctrine, during the seventeenth and eighteenth centuries, the most illustrious names are those of Grew, Camerarius, Geoffroy, Bradley, Burckhardt, Moreland, Vaillant, L. Logan, and Spallanzani. In times anterior to this period, great, in all probability, were the merits of Caesalpinus, and perhaps of Zaluzianski, the Pole. Future inquiries will, I think, show us, that the Arabian philosophers were all acquainted with the fact of the necessity of a sexual intercourse in the Date, and other vegetables: and every student of vegetable physiology knows, that Dioscorides, Pliny, Theophrastus, Aristotle, and even Herodotus, have spoken of the mode of fecundating the Palm, which we have just called the Date. One, indeed is irresistably led to believe, that the doctrine of the sexes of plants is one of the most ancient facts relative to vegetable physiology, of which any memorials are preserved. But it is not my object, in this work, to detail the progress of the steps by which mankind have arrived at the precise knowledge, which they now possess, concerning the Sexes of vegetables. This is an investigation the discussion of which I reserve for another work. In the meanwhile, I shall merely observe, that I have not yet met with any thing like a full, candid, and satisfactory view of the subject. Dead to the public eye, as it were, are the merits of many eminent writers, who preceded L. in the beautiful inquiry concerning the sexes and *sponsalia* of vegetables. How little has yet been said concerning the learned friend of Leibnitz, who as early as the year 1702, (a few years before the birth of L.) was not only well acquainted with the existence of sexes, and of sexual intercourse, in plants, but even suggested the outlines of that arrangement of plants, which is now denominated the Systema Sexuale. The arguments or proofs, in support of the doctrine of the sexes of plants, and of the necessity of an intercourse between them, in order to produce a fertile offspring, are many: and the principal of them have been noticed by L. or by his pupil Wahlbom, in the valuable paper entitled *Sponsalia Plantarum.* It is not necessary, in the very brief view of the subject which I am exhibiting, that I should follow the precise arrangement of the paper which I have mentioned: an arrangement, it must be confessed rather scholastic than neat or perspicuous. 1. I shall open this part of my subject by noticing the argument which L. calls Palmicolæ or the culture and fecundation of the Palm-tree. Some of the very earliest observations of mankind concerning the existence of sexes in vegetables, or at least of the necessity of something like an intercourse between the different individuals of the same species of vegetables, in order that fertile fruit might be produced, are those which respect the

Date, or Phœnix dactylifera, and other Palms.* From the time of Herodotus,† who has left four or five curious lines upon this subject, down to our own age, many authors have informed us,—and the fact seems to be completely verified,—that the female Date will not bear abundant, well flavored, and fertile fruit, unless the male plant be placed near to her: and even in many instances, unless the female or fruit-bearing Palm be *artificially* impregnated by the male flowers. The observations which the immortal Tournefort has communicated to us on this subject are all important; and the more so, as this celebrated man never yielded to the belief, that the stamens and the pistils are the sexual parts of plants, and even treated the doctrine of the sexes of vegetables with a species of contempt, unworthy of his caution and science.‡ How unlike his pupil Vaillant! who, but a few years after the death of Tournefort, and while L. was yet a boy, completely established the great and fundamental facts which support the doctrine which we are considering. See what has been said by Hasselquist, by the elder Michaux, by the estimable Desfontaines *(Flora Atlantica,)* and other botanists and observers. The reader will find a good view of the argument Palmicolæ in Mr. Milne's *Botanical Dictionary*, article sexus: and he should peruse, with attention, the late Dr. Rotheram's answer to Mr. Smellie's objections against the doctrine of vegetable sexes in general, and especially the plausible arguments of Smellie to weaken the force of the famous Berlin experiment, made by impregnating a female Palm (Rhapis flabelliformis?) with pollen brought from Leipsic. The argument Palmicolæ may, with some propriety, be considered as the corner-stone of the doctrine of vegetable sexus.

2. The argument Caprificatio, or Caprification, by which we mean the very singular husbandry or management of the Caprificus, or Wild-Fig, is extremely curious; and if all the assertions which have been made in regard to this species of husbandry, might be depended upon, they would of themselves go very far to establish the truth of the doctrine of vegetable sexes, as well as the necessity of insects in the business of fecundation. See what has been written upon this subject, by Tournefort, Pontedera, Mr. de la Hire, Desfontaines, and others. See also, the article Caprificatio in Milne's *Dictionary*. I will only further observe, that the subject deserves a more critical, and even a more skeptical attention, than it has yet received at the hands of any philosophic botanist. The inquiry might be pursued with great advantage in the Southern parts of the United States, where the Fig, though not idigenous, attains to great perfection.

* Dr. J. R. Forster assures us, that the people of Otaheite, when first visited by the English, were acquainted with the sexes in the Coco-Palm, and in other vegetables. *Observations, &c.* p. 498, &c.

† Herodotus, in Clio.

‡ Tournefort considered the pollen as a mere excrementitious matter of the flower.

3. The argument Præcidentia deserves attention: and this, indeed, holds a primary place in the Linnæan view of the subject The vegetable fruit is not formed, until the flower has made its appearance. "These two parts it has already been observed are connected in the same manner as generation and birth are connected together in animals." This well-established fact sufficiently proclaims the vast importance of the flower, or at least some of the parts and organs of the flower, in the business of generation. Some facts, indeed, seem at first sight to oppose the general position which has been laid down. Thus, the fruit and the leaves of the Colchicum autumnale, or Meadow Saffron, make their appearance and are brought to perfection in the early spring, although the blossoms do not show themselves until the autumn. But on a closer examination, we find, that the pollen of this plant is shed in the autumn; at which time the germen, or seed bud, begins to be enlarged; but as this important organ is not completely gravid, until the following spring, superficial inquirers have imagined, that tbe Colchicum opposes an objection to the rule of *præcidentia.* In Franklinia, also, the beautiful flowers which yield to none in fragrancy, seem to be preceded by ripe fruit. "A Pine-apple (says Dr. Smith) was once very unexpectedly cited to me, as an instance of fruit being formed before the flower, because the green fruit in that instance, as in many others, is almost fully grown before the flowers expand. The seeds, however, the essence of the fruit, are only in embryo at this period, just as in the germen of an Apple-blossom.

4. The very general, and indeed almost universal, existence of the stamens and pistils in plants, either in the same calyx or corolla, or in the flowers of different individuals of the same species, is now on all hands acknowledged: and cannot but be considered as a main argument in support of the doctrine of the *sponsalia* of flowers. It is true, however, that these organs have not been detected in *all* plants: nor is there, I think, reason to suppose, that they do actually exist in all plants. But, doubtless, they will be discovered in many in which they have not hitherto been observed. In different species of Lemna, already mentioned, both the stamens and pistils have been recently fully investigated: and these plants have very frequently united flowers. About the mosses, we are no longer in doubt. It is not necessary to suppose, that the stamens and pistils exist in every plant. It would be almost ridiculous to suppose, that this were the case. It is sufficient for our purpose, that these organs have already been discovered in the greater number of vegetables that are known to us: and wherever we have detected them, they appear to be, indisputably, the true organs of sexual reproduction.

5. The arguments of Situs and Proportio, or the situation and proportion of the stamens and pistils, are next to be noticed. *a.* In the greater number of flowers, these organs are situated in the same calyx, or corolla, as in all the truly androgynous plants, such as the Lily, the Tulip, the Rose, the Apple, and ten thousand others. In these plants,

with comparatively a few exceptions, the pollen, even without calling into view the aid of insects, or the spontaneous or elastic movements of the supposed sexual organs, is almost unavoidably thrown upon, or applied to, the pistil. The germen, of course, is readily fecundated, if the pollen be, indeed, as the Linnæan School suppose it is, the true *genitura*,* or fecundating material, of plants. It is a scandalous assertion of the ingenious William Smellie, that no one sees the pollen upon the stigma! *b.* In the *flores nutantes*, or drooping flowers, the stamens are, for the most part, shorter than the pistils: while in the erect flowers, they are commonly longer. Owing to this proportion between the two sexes, it is easy to perceive that the pollen more readily reaches the stigma. If, in these drooping flowers, such as Snow-Drop, Campanula, and Fritillaria, the stamens were longer than the pistils, impregnation could not, without insectile or other aid, be effected: the pollen would fall *from*, instead of *upon*, the stigma. *c.* In the compound flowers of the vast class of Syngenesia, there are but few examples of plants which do not ripen their seed. L. very naturally supposes, that the fertility of these plants is owing to the peculiar structure, or rather disposition of the anthers, which form a ring, that is, in a manner, perforated by the female organ.† See our Plate XXXV. Fig. 5. *d.* In the plants of the class Monoecia, where the stamens and pistils are situated upon different parts of the same individual plant, the disposition of the blossoms is, in general, such as to favour the ready application of the pollen to the styles. Thus, in the Zea, or Indian-Corn, in the Coix, or Job's-tears, in Carex, and many others, the male flowers are placed *above* the females, and the falling pollen unavoidably passes to the styles. *e.* In other monoecious plants, it is true, that the disposition of the male and female flowers is reversed. Thus, not to mention others, in the Zizania, called about Philadelphia, Reed, and well known to every sportsman, as the favourite resort of the delicious Rice, or Reed-bird (Emberiza Oryzivora,) the male flowers are placed *below* the female. But in this plant, and in others with similarly disposed organs, impregnation is not prevented. And it is a fact, that many of those monoecious plants, which have the male organs thus (to appearance) less advantageously situated, secrete a prodigious quantity of pollen. I have seen many bushels of the pollen of different species of Pine carried by high winds, from the distance of several miles, and in the course of a few hours, into the streets of Philadelphia. An appearance like this has often

* I employ the terms genitura and pollen, when speaking of vegetables, as perfectly synonymous.

† L. refers the argument derived from the Syngenesious plants to his article Oculus. "Syngenesiæ stigmata per cylindrum antherarum surgunt; quum itaque emergit stigma semper genituram fecundantem secum fert, unde fecundatio hic raro fallit." Wahlbom, in *Sponsalia Plantarum*, in *Amœnitates Academicæ*, vol. i. p. 90. Lugduni Batavorum, 1749.

alarmed the vulgar and the superstitious, in the countries of the old world. And a portion of mankind is not yet so enlightened, as not to tremble,—as at the coming of the last day,—when the winds shall scatter over the fields and the gardens, the cities and the towns, that very matter, which nature has provided for the perpetuation of her vast and beauteous world of vegetables. 6. In the greater number of plants, the pollen and the stigma are observed to be in perfection at the very same time: and this not only in the plants whose flowers are androgynous, but in the great families of the classes Monoecia and Dioecia. See something further on this subject, which constitutes the argument Tempus of Linnæus, in another part. 7. In not a few plants, the stigma and the style appear to be imperforate, or solid, at all times except when the pollen is about to be discharged. Then the stigma gapes to receive the genitura; after which it closes, and perhaps opens no more. See what has already been said on this subject in regard to the Gratiola, in the former pages. The same phenomenon is observable in the Viola tricolor, in the American Martynia, and in other plants. L's. pretty story about the Amaryllis formosissima, or Jacobean Lily, which is repeated by Dr. Smith, requires, in my opinion, to be more carefully looked into. It is certain, however, that the stigma in many plants, is endowed with an irritable power, which is chiefly observable at the time the pollen is to exert its influence. Many curious facts might be mentioned here concerning the opening and closing of the stigma in different species of Lobelia, but especially in the superb Lobelia Cardinalis, or Cardinal flower, and in the Lobelia siphilitica, praised for its supposed power of curing the disorder from which it receives its trivial name. I have distinctly observed the same phenomenon in Mimulus aurantiacus. Between these phenomena and the changes which take place in the oviducts of certain *reptilia*, or amphibious animals, we have a beautiful instance of analogy, unknown to L., but which gives much strength to his system of vegetable *sponsalia*. The illustrious Spallanzani, who, without wishing to do it, has often beautifully supported the doctrine of vegetable sexes, has informed us, that in the frog, he found the oviducts imperforate, except at the season of their amours.—I have learned, by the application of artificial and undue stimuli, to render the opening and closing of the stigmas and styles of certain plants peculiarly obvious.

8. Something is said in the latter part of this work, concerning the late appearance of the leaves of those trees and shrubs whose stamens and pistils are not situated within the same individual flowers. "Nature has wisely ordered it, that in these particular plants, the sexual organs shall, in general, make their appearance before the full evolution of the leaves, so that the fecundation is not hindered by the intervention of the leaves." The value of this argument, however, is much diminished by our observing the same phenomenon in many vegetables, whose flowers are androgynous. Thus, not to mention other examples, the Peach displays its lovely blossoms in perfection, and in great profusion,

before the leaves are evolved. And the American Cercis, which so eminently enlivens the opening spring of the United States, and adds, in particular, a glowing charm to the borders of our rivers, exhibits hardly the vestige of a green leaf, until the rites of marriage have been performed. Yet the Cercis, like the Peach, has androgynous flowers. If I understand Dr. Smith, he means to tell us, that the trees of hot countries, "whose leaves being always present, might impede the passage of the pollen," are more frequently furnished with androgynous flowers, than the deciduous trees of colder climes. But how does this observation accord with that of Dr. Foster, which I have quoted in a part of these *Elements?*—Our knowledge of final causes is but too limited.

9. Under the argument Pluviæ, or Rains, we meet with some very curious facts, which can hardly fail to be considered as proofs of the doctrine which we are considering. Many flowers are observed to fold together their petals, or to droop their heads, during the night-time, or during the continuance of rains or heavy dews. By this delicate connivance, as it has been called, the stamens are protected, and consequently the pollen is preserved from injury. Many flowers, and among others the following, Convolvulus arvensis, Anagallis arvensis, and Calendula pluvialis, regularly close their flowers on the approach of rain. Hence, one of these plants, the pretty Anagallis, or Red Pimpernel, has in England, received the name of the "Poor-man's weather-glass."*

L. asserts, that flowers lose this peculiar irritability, or contractility after the stigma has been fertilized: a fact, which, if *completely* established, would go far to prove, that we are thoroughly acquainted with the final intentions of these movements of the petals of plants. But I could urge,—and may elsewhere offer,—objections against the perfection of our knowledge on this item of the physiology of vegetables. "At stigmate (these are the words of L., or of Wahlbom,) mirum sane! semel fecundato, nec vespere nec pluvia ingruente, sese contrahunt flores." "I have had reason to think (says Dr. Smith) that, during a long continuance of wet, the sensibility of the Anagallis is sometimes exhausted; and it is evident, that very sudden thunder storms take such flowers by surprise, the previous state of the atmosphere not having been such as to give them due warning."†

L. asserts, that plants of the two classes Didynamia and Diadelphia, whose anthers are covered, do not close at night-time. But this observation is by no means correct. The class of Diadelphia, in particular, supplies us with many exceptions to the Linnæan rule: and so does the class of Decandaria, so far as its papilionaceous-like flowers are concerned.

* Dr. Smith, &c.

† The Tulips closed their petals during the *deliquium*, or Solar eclipse of 1706.

As moisture causes the vegetable pollen to explode, or renders it clotted, it is easy to conceive, that rains, or heavy dews, must, from the peculiar organization of many plants, interfere with the free and regular functions of the anthers. We seem to have an illustration of this observation in the great family of the Cerealia. In the Rye, the anthers being protruded considerably beyond the glume, are apt to be much injured, and a sparing crop to be the consequence, if heavy rains, or long continued wet weather, occur during the flowering of this plant. During a similar condition of the atmosphere, the Barley suffers much less, as its anthers are more protected within the glume. We owe these observations to L. and I believe that the truth of them has been confirmed by the experience of the husbandmen of the United States, as well as of Sweden, and other European countries. L. also informs us, that rains do not so essentially interfere with the production of a crop of Cherries, as with a crop of Pears, "because in the former the opening of the anthers is, in each blossom much more progressive, so that a longer period elapses for the accomplishment of the fertilization of the germen, and there is consequently less chance of its being hindered by a few showers." Upon the whole, though the argument derived from rain, is extremely curious, I do not deem it so conclusive as did L. and as do many of his scholars and admirers. The *native* vegetables of the hottest countries are so far from being deficient in the production of various species of grains and fruits, that they are among the most fertile with which we are acquainted. No one has yet shown us, that the constant and violent rains of Abyssinia, against which nature is said to have furnished the trees of that country with varnished leaves, prevent the production of very abundant crops of grains and fruits.

10. Under the L. head of Submersi, some very interesting facts occur. Not a few plants pass the greater part of their life under the water: but when the season of generation arrives, they rise near the surface, that the impregnation may take place without injury from the water. When this important act has passed, these plants again retire under the water, where the germs enlarge, and the seed are sown. Ruppia, maritima, or Sea Tassel-grass, which grows in America as well as in Europe.—The economy of Valisneria has been noticed by the learned Italian, Micheli, and since his time by many other botanists. But some circumstances in the history of this plant have not, I think, been altogether accurately stated. The barren or male blossoms which grow on short foot-stems; do not *fall off*, and swim about to meet the female flowers in the same vicinity. The supposed detached male flowers are nothing more than the pollen of the plant, (or perhaps the anthers) detached from the male flowers, which continue attached to their short parent scape. See the imperfectly detailed history of this plant in the *Genera Plantarum* of Micheli; in Wahlbom's paper, *Sponsalia Plantarum*, p. 76. in Willdenow's *Principles of Botany*, page 320; in Dr. Smith's *Introduction*, &c. &c. Willdenow expressly says, that the male flowers drop off: and in this, he

has followed L. In whatever light, however, we view the economy of Valisneria, which is a common plant in many of the rivers, and other waters of America, the history of this plant becomes highly interesting to the physiological botanist. But we still desiderate some facts in regard to the history: and I cannot help smiling, when an eminent botanist tells us, that the plant is "well figured," by Micheli. It is not pretended, that there are no aquatic vegetables which blossom and impregnate under water. If I do not mistake, there is a great number of such. Chara, remarkable for the quantity of lime which it yields is one of them. In this plant, and in others which blossom and perform the rites of *sponsalia* under water, the pollen is observed to be peculiarly glutinous. But many plants which blossom in the dry air, have also pollen nearly of a similar quality.

11. I cannot attach any great value, in this inquiry, to the L. argument of Fumus. I know, that many vegetables produce more ample crops of fruit within the walls, or bounds, of large towns, than in adjacent country situations. I now proceed to mention some arguments and facts, which I cannot but deem of higher value than the greater number of those which have already been mentioned. Some of these facts, indeed, as completely establish the doctrine of the sexes of plants, as do any facts with respect to animals, prove the doetrine of the sexes of this still greater family of organized bodies. I will go farther, and assert, that a few of our known facts, belonging to some of the different heads which I am to mention, most loudly proclaim a truth, which some late Philosophers* have begun to doubt, that plants are not only organized but *irritable* beings. I am compelled to advance still further in my view and apprehension of these facts. I am persuaded, that plants have something like an instinctive perception: and it even seems probable that nature has not wholly denied to vegetables at a particular season of their life, a portion of that *gaudium*, or *voluptas*, which all legitimate naturalists have allowed to animals, of whatever classes or families, during the seasons of their love and amours.—I have great satisfaction in believing, that these opinions, even if they be wholly unfounded, do not, in the smallest degree interfere with the best views and interests of religion and morals.

12. To facilitate the impregnation of the stigma, nature has, in very many plants, established an economy, which renders the great business of which we are speaking, inevitable. Both the stamens and the pistils are endowed with an *irritable* power: and in many plants with an *elastic* power. When the pollen is ripe, and fitted to perform the important offices for which it is destined; or, as we may express ourselves, under the influence of the stimulus of the pollen, the stamens, in many plants, approach the style, and apply the pollen to the stigma. These movements of the stamens, in many plants, appear to be truly spontaneous, or to depend upon an extremely light

* Sir Humphry Davy, &c.

external irritating cause. We have beautiful illustrations of these movements of the stamens in the common Barberry, (Berberis vulgaris,) in different species of Cactus, or Indian Fig, and in many other plants. In Kalmia latifolia, and other species of this noble American genus, the movements of the stamens, by which the pollen is very readily applied to the stigma, are more evidently of an elastic nature.

Celosia, or Cock's-comb, has five stamens, the filaments of which, at their lower part, are connected together by means of a membranous web *(membrana plicata.*)* This structure like many other parts of the structure of vegetables, is very sensible to the changes of the atmosphere. During moist weather, the membrane becomes relaxed, in consequence of which the stamens change their position, and shelter themselves beneath the concave lobes of the corolla. In dry weather, on the other hand, the membrane becoming contracted, the stamens connive, or are brought together, and thus the pollen is readily spent upon the divided summits of the style.† In the Saxifrages, of which the United States furnish us with several species,‡ in which the phenomenon which I am to mention, is readily observed, the stamens, one or two at a time, lean over the stigma, and having shed their pollen retire and their place is supplied by others of the stamens.§ Yet although *all* of the ten stamens have a share in the business of fecundation, experiments show us that the pollen of any one of them is sufficient for the purpose. Nearly the same phenomenon is observable in the beautiful genus Parnassia, or Grass of Parnassus, of which we have now discovered in the United States, at least three distinct species. It is pleasing to notice this phenomenon in Parnassia asarifolia. It seems altogether unnecessary, in this place, to pursue this inquiry, by individual examples, any further. The curious student of botany will find many other examples, nearly similar to those which I have mentioned, of the movements of the vegetable *genitalia*, in the writings of botanists: and especially in the memoir of Mr. Desfontaines, and in the neglected inaugural essay, *De Plantarum Motibus et Vita*, of the present Professor Hope, of Edinburgh. I hope, at some future period, to publish the results of my own numerous experiments and observations, relative to the same highly interesting subject. It has been observed, and I believe the observation is generally correct, that we have more instances of the movements of the stamens, towords the pistils, than of the pistils towards the stamens, at the period of the fecundation of plants. In this respect a fanciful analogy

* This membrane is considered by some botanists, as a true nectarium *nectarium plicatum.*

† Sponsalia Plantarum, p. 97.

‡ Especially Saxifragra Pennsylvanica, called chocolate-root; and Saxifraga Virginiensis. These are both early flowering plants, delighting in very opp- site soils and situations.

§ Sponsalia Plantarum, p. 97.

between plants and animals has been imagined. In not a few plants, however, the pistil is the moving organ, taking the pollen from the anthers, which remain immovable. Not to mention many other plants, we have a beautiful illustration of this phenomenon in the American Collinsonia Canadensis, and in other species of the genus. See Plate IX; and the explanation of this plate. I am now to pay some attention to two of the most important of all the Linnæan arguments in support of the doctrine of vegetable sexes: the arguments which the Swede has denominated Castratio and Abscissio.

13. Innumerable experiments have now been made; which most satisfactorily prove, that when we cut off, or remove, the anthers of a plant, taking care at the same time to prevent the influence of the male genitura of any other plant of the same species, the germ of the plant thus treated will not swell: or if it do, that its seed will never prove efficient. This forms the first of the two arguments which I have just mentioned. Under this head, I shall content myself with mentioning three experiments, one by L. and the others by myself. L. took off the anthers from a flower of the Glaucium corniculatum* or Red Celandine, at the same time, taking the precaution of removing all the other blossoms of that day's opening. He repeated the same practice on another morning, "only sprinkling the stigma of that blossom, which he had last deprived of its own stamens, with the pollen from another. The flower first mutilated produced no fruit, but the second afforded very perfect seed." "My design, (says L.) was to prevent any one in future from the believing, that the removal of the anthers from a flower was in itself capable of rendering the germen abortive." I have quoted Dr. Smith's account of this neat and satisfactory experiment, not having the work of L. in which it is related, at hand. I repeated this experiment, nearly in the same way, and I hope with equal precision in two plants closely allied to the Glaucium, and belonging to the same natural order of *Papaveraceæ*, and to the Linnæan class and order of Polyandria Monogynia. I mean the Elegant Blood-Weed (as Hill* calls it,) or Sanguinaria Canadensis; and in the Jeffersonian Bartonis. The result was satisfactory, and convinced me that without the aid of anthers, no ripe seed could be produced in either of these plants.

14. In like manner, if we cut off the stigma of a plant, before it has received the fertilizing influence of the pollen, no ripe seed will be produced from the germen of the injured pistil. The argument *Abscissio* of L.

15. Experiments, if possible, more decisive than these have been made and with the same results. Without mutilating, or essentially

* Glaucium phœnicium of Smith, Flora Britannica, tom. ii. n. 2. p. 564. Red Horned Poppy.

† Vegetable system, vol. 16. page 31. plate 31. Icon non pessima, "in opere pessimo."

violating the organs of which I am speaking, they have been prevented from having access to each other. Thus, in the experiments of James Logan* and other botanists, or lovers of the Science, the fascicle of anthers, which we call the "tassel," immediately upon its making its appearance, was wrapped up in paper, or muslin, before it could shed its influence upon the silken styles below. The consequence has been uniform. No fertile seed have been found in this plant; if sufficient precaution had been taken to prevent the access of the pollen of any other specimen of the Mays in the immediate neighbourhood.

16. The production of Hybridæ, or Mule Plants, by the intermixture of two plants of the same, or of different genus, supplies us with a most important, indeed an invincible, argument in favour of the doctrine of the sexes and *sponsalia* of plants. On this subject, the reader may consult the paper entitled *Plantæ Hybridæ*, in the *Amœnitates Academicæ, &c.*† But this is not one of the most happy productions of the Linnæan school. I agree with Willdenow, that the author of this paper "has given nothing but hypothesis, his observations not according with experience." It is to the ingenious and patient Koelreuter that we are indebted for our most important information, the result of actual experiments, on this subject. I shall principally confine myself to the relation of his experiments, which is indeed, the most important of which the beautiful science of vegetable physiology can boast. He fixed upon the Nicotiana religiosa (as I call it,‡) or Onondago-Tobacco, and deprived it of all its five stamens. He then applied to its pistil, or stigma, pollen of another American Tobacco, the Nicotiana paniculata. The germ of the N. religiosa swelled, and in due time produced good seed, which vegetated, and exhibited a new species of Tobacco. It was neither N. religiosa nor N. paniculata, but "kept in all its parts the middle between the two species." This simple experiment, while it sufficiently establishes the fact, that the stamens are the male, and the pistils the female, organs of plants, is also worth whole volumes of speculations in our view of the two doctrines,—espoused, it must be confessed, by men of nearly equal talents and learning,—called Epigenesis and Palengenesis. It is certain, that both the male and the female plant contributed, and nearly equally, to the formation of the Nicotiana hybrida. And the same seems to be the case in the production of other mule plants. Thus, although the vegetable,

* Founder of the excellent Loganian Library, in Philadelphia. Among the number of valuable and very rare books which this library contains, the curious botanist will not be displeased to learn, that there is a copy of the celebrated and rare *Epistola* of Burckhard to which I have alluded in a former part of this section.

† Vol. iii.

‡ Nicotiana rustica, *Linn*—Bulliard, t. 289. Icon bona, non optima.

as well as the animal, genitura contains *animalcula*, it must be admitted, that these animalcules are not the *pre-existent* plants, which only require for their evolution, the stimulus of the pollen.* In general, hybrid plants are not fertile; in this respect, following the law which governs hybrid animals. But instances of fertile mule plants are known to us: and it is probable that there are many others, not suspected by us. Sorbus hybrida, Pyrus hybrida, Rhamnus hybridus.

17. The odour of the male genitura of animals is well known to be very peculiar. It has been denominated a *specific* odour. Nearly the same odour is observable in the anthers, or pollen, of many plants. This has already been remarked in regard to the Veratrum luteum.† It is still more perceptible in the flowers of the Chesnut and Chinquepin, in the spadix of Orontium aquaticum, and in the flowers of the Arabian Lawsonia, Magnolia tripetala.

18. The doctrine of the generation of vegetables derives additional and great support, from the chemical analysis of the pollen, a subject to which L. paid no attention, and which, indeed seems not to have engaged the notice of any of the many philosophers who were contemporary with him, and whose inquiries were directed to the most interesting subjects of the functions of the stamens and the pistils. The late inquiries of Fourcroy and Vauquelin have shown us, that the pollen of the Date, the Pine, and other vegetables, yields by analysis very nearly the same products as does the human genitura. The most interesting of these products is the phosphate of lime.

19. The flowers of Plants, and especially the stamens and pistils, are much altered in their appearance, after the act of fecundation has been accomplished. In relation to this point, we have a beautiful fact mentioned by L. The female organs of the Hemp, which had received the influence of the pollen, faded and withered soon after: while in those individuals which were separated from the males, the stigmas continued green and vigorous for a considerable time. Of the American Comptonia I have observed, that the female flowers, which appear a good while before the males, continue in beautiful vigor for a long time: but no sooner does the pollen reach them, than their whole aspect is changed. Many similar facts might be mentioned.

In the Hippocastanum of Pindus, the bush of the petals is changed to a greenish hue, immediately after impregnation: and it is not difficult to determine, merely by an attention to this change of hue, whether the stigma has been impregnated or not. It is probable, that the well-defined painted *maculæ*, or spots, which we find upon the petals of many other blossoms, as those of Pontederia cordata, undergo a similar change in consequence of impregnation.

20. That various species of insects, particularly, perhaps, bees, tripulæ, &c. by conveying the pollen of many plants to the stigma, ren-

* Helonias lutea,—Gawler in Curt. Bot. Mag. n. 1062.
† Spallanzani, Bonnet, Haller, &c.

der the impregnation of the latter more certain, and especially in the monoecious and dioecious plants, I have already admitted to be a fact. But I must confess, that hitherto I have not met with any facts which lead me to believe, that in any plant, the great business of impregnation is *necessarily* dependent upon insectile aid. On this subject I feel no disposition to alter my general sentiments, as delivered in the first edition of this work, and which are retained, without the least variation, in the present edition. The late excellent Mr. Willdenow's curious observation concerning the impregnation of Aristolochia Clematitis, goes farther than any other fact that I have yet met with, to show, that with respect to some plants, insects are necessary to give fertility to the female organ. The professor, indeed, maintains it is an axiom, that, "the dichogamic plants can be no other way fecundated than by insects."* For the history of the Aristolochia Clematitis and that of the Tipula pennicornis, I must refer my readers to Willdenow's work,† and to that of Dr. Smith, who does not doubt the accuracy of the great German botanist's account, "though (says Dr. Smith) I have never caught the imprisoned Tipula." I am at a loss to conceive how the impregnation of the female of different species of Sarracenia is effected. The broad peltated stigma completely covers over the numerous stamens, and prevents their pollen from being applied to the *upper* surface of this organ. Are insects necessary here? It is certain, that the species of the genus of Sarracenia, are visited by many species of insects. See Plate I. also the explanation of this plate. I have thus brought to a conclusion, a very rapid view of the principle arguments, or rather heads of arguments, in support of the doctrine of the sexual functions of the stamens and the pistils. Enough, I think has been said to satisfy the most incredulous mind, that the stamens, or anthers, in a vast majority of plants, are the male, and the pistils, or stigmas, the female organs of generation in vegetables. Yet, I must confess, in concluding this interesting inquiry, at which the great Lord Bacon, with his views of the subject, would have smiled, —that the question is still open to numerous experiments, which ought to be made, in order to complete our knowledge of the subject. It seems, indeed, to be admitted, by some able writers, and among others recently by Mr. Knight,‡ that the experiments of Spallanzani are not of so much weight, as the late Dr. Beddoes and others imagined they were. I may add, that the experiments of the Italian naturalist were repeated with very different results, by the late Dr. William Alexander, of Halifax, in England; whose memoir on this subject, I had the pleasure of hearing read, at a meeting of the Natural History Society of Edinburgh. But, although in the conduct of his experiments, Spallanzani may have committed mistakes, and may, indeed, have been im-

* Principles &c. page 318. † Principles &c. pages 316, 317.

‡ Transaction of the Royal Society of London. For the year 1809. Part ii. Page 399.

posed upon, with *professoinal* malevolence, by some of his colleagues, I am still inclined to suspect, that as there are some secrets with respect to the generation of plants, so it is not yet established as a fact, that fertile seed are *never* formed without the influence of the pollen. —Clitoria mariana.

SECTION VII.

OF THE SUPPOSED PRINCIPLES, OR ELEMENTS OF VEGETABLES.

I shall now now give a section on the chief Principles contained in vegetables. 1. *Caloric* is, doubtless, present in all vegetables; and when it is free, may be said to constitute their temperature. Plants have unquestionably, a temperature of their own. It is not difficult to measure it in some plants, such as different species of Arum, &c., during the period of their florescence. Dead vegetable matter freezes with much more readiness, than living matter of the same bulk, weight, and species. Some species of plants resist very great degrees of cold: as they do also, high degrees of heat.—Rhamnus alaternus,—Tremellæ. —2. *Light* is found in the oils and other inflammable substances of numerous species of vegetables. 3. The electric fluid is said to "show itself by various electric phenomena observed in plants." Nor do I doubt that this is actually the case. I must repose some confidence in electric appearance said to be discovered, by one of the daughters* of L. in the Tropacolum majus or Indian Cress; and in other plants, by other observers. Yet I am not ignorant, that the late Dr. Ingenhauz doubted the existence of any plants naturally and exclusively *luminous*.—4. *Carbon* forms a large part of the whole mass of vegetables. It is much more abundant in some vegetables than in others. It is one of the nutritious principles of vegetables, as well as of many animals. 5. *Hydrogen* is readily obtained in a gaseous form, in combination with caloric, from many vegetables, especially perhaps from the Leguminosæ, from the Tetradynamiæ, and from some of the Fungi. 6. *Oxygen* is readily evolved from plants, of almost every species, by the agency of the solar light. It also exists, combined with certain bases, in the various acids which are found in vegetables. Whether it really constitutes the acidifiable principles of all these acids, we are not to inquire. 7. *During* the night-time, plants exhale Azote. A much greater portion, however, of this principle remains in a combined state, as in the Tetradynamiæ, Fungi, &c. 8. *Phosphorus* exists abundantly in plants: and in plants of very opposite classes. See Tetradyna-

† Flores ante crepusculum fulminant, observante. E. C. Linneæa. *Linn.* Species plant. vol. i. p. 490. See Darwin's Botanic Garden, Part ii. Canto iv. l. 43, &c.

mia, and Fungi. The existence of phosphorus is sufficiently manifest by the shining of old rotten wood of various kinds: by the shining of the root of the common American Potatoe, or Solanum tuberosum. 9. *Sulphur* is found in very many plants. It exists, in the state of sulphuric acid, in union with potash,—with soda,—with lime, &c., forming the sulphates of these substances, commonly denominated vitriolated tartar, glauber's salt, and gypsum, or plaster of paris. It also exists in the state of a sulphate of iron, or copper, in the Chesnut, Chinquepin, &c. But sulphur even exists in substance, in certain vegetables, as in the roots of Rumex Patientia, in Cochlearia, &c. It is I think, almost certain, that much of the sulphur which is found in certain marshy tracts of the United States, &c., is owing to the decomposition of wood. 10. *Soda*, now no longer considered as a simple substance, but as an oxyde of a peculiar metal,* exists in many plants, but especially such as grow on the shores of the sea, in the vagrant Fuci, formerly mentioned, and in the more inland plants, especially when the soil is largely impregnated with sodane, or common salt. The muriatic salines, or marshes, famous for furnishing the zoologist with the remains of extinct animals (especially Elephas Mastodontus, &c.) supply the botanist with many plants in which soda exists, such as Salicornia Glaux, Triglochin, &c.—Plants readily absorb soda. 11. *Potash*, or oxyde of potassium, also exists abundantly in vegetables, especially the arborescent inland trees, such as the Hickory, the Oak, &c. Some herbaceous plants yield a great deal of it, such as Sigesbeckia occidentalis, called Stickweed, in Virginia. It is asserted, that plants naturally yielding potash, when transplanted to the muriatic soils, are found to yield soda; while those of the latter soils, if transplanted to the inland tracts of country at a distance from muriatic impregnation and influence, yield potash. These things deserve the attention of the chemists, and may lead to very curious results. 12. *Silica*, or the flinty earth is found in the culm of the Bambusa arundinacea, or Bamboo; in the Arundo Phragmites, or common Reed, &c. In some of these plants, it is in a detached state, constituting the *Tabasheer*. It exists very largely, in the epidermis of the Equisetum or Horse tail, as Sir H. Davy has shown: and it is probable, that the injuries which are done to horses which eat of the Equisetum, is much more owing to the mechanical action of the silex than to any other property of this cryptogama. Does not silex exist in Betula Alnus, or Alder,—in the Betula serrulata, or Candle Alder, which gives its Indian name to one of the branches of the Susquehanna?—and in other species of the genus? 13. *Alumina*, or Alumine, has been found in a few vegetables. It will be remarkable if it do not exist in many of them, in the shape of sulphate of alumine, or common alum. Heuchera Americana, called Alum-Root. 14. *Magnesia* is also said to exist in some plants, as in

* Sodium of Sir Humphrey Davy.

the American Indian Corn. Can it well be wanting, in some of the many vegetables of Pennsylvania, and other countries, which grow in Magnesian soils?—It is not true, as has been asserted, that seeds and other vegetable parts will not vegetate in magnesia. I find, that certain seeds germinate very well in a soil consisting of more than one half of carbonate of Magnesia.

15. *Barytes*, or the heavy earth, has been found in plants, and especially in the Gramina or Grasses. 16. The existence of Lime, or calcareous earth, in plants, was once denied. L., Ellis, and others, were of opinion that this earth, or oxyde of calcium as it is now considered, does not exist in the vegetable kingdom. And these eminent men even fancied, that the want of lime in vegetables might serve to distinguish this vast kingdom of organized bodies from that of animals, in whose constitution lime is known to abound. Many plants contain lime. A pound of Chara tomentosa is found to contain several ounces of it. Lime seems to be so far from being foreign to vegetables, that it exists in not a few of those which we eat. Does it not exist in the seeds of certain plants, as in those of the Lithospermum arvense, called in Pennsylvania, Stone-Seed, and Pigeon-Wheat? It certainly, exists in some of the Lichens; and if I mistake not, they derive a portion of their nourishment from this earth. Even in the arborescent vegetables, we find lime; and it adds not a little to the stability, weight, strength, and durability of such woods, as Desaussure has shown. In some plants, we are told, there is not a vestige of lime. The fungi* are said to be of this number. More experiments on this subject are wanted: and, lime, I think does exist in the Deer-Turnip, one of these vegetables.—See in another part. 17. *Iron* is found in the ashes of many plants. I have already mentioned its existence, in the form of a sulphate in the Castanea, of two species.. Iron is not unfriendly to the growth and vigor of plants. They readily absorb its sulphate, as I have proved by many experiments.—Is it at all probable, that the great and peculiar attractions which certain trees seem to have for the electrical fluid, or lightning, is, in any degree, owing to the existence of an unusual quantity of metallic matter in the composition of such trees? It is not probable that this is the cause of the attraction.—Castanea, Liriodendron, Juglans nigra, are often struck. Fagus ferruginea, or the Amer. Beech, never. 18. *Manganese*, has also been found in plants. 19. *Gold*, it has been asserted has been detected in the Vine, or Vitis vinifera, in Quercus Robur, in Carpinus Betulus, or Horn-beam, in the Hedera Helix, or Poet's Ivy, and in a few others. Perhaps, no dependence is to be placed upon these assertions. But I think we go too far when we assert, that the existence of gold in any vegetable is "impossible." 20. Tin is said to exist in the Spartium junceum, or Spanish-Broom. The elements or substances, whatever we may think proper to call them, which have been enumerated in the preceding list, were until lately considered as

* Especially, it is said, the genera, Peziza, Octospora, and Byssus.

elementary or simple substances as they had not been decomposed: and many of them it was imagined, were indecomposible. But the great revolution in chemistry, effected by the genius and labours of many illustrious men, have given us new and very different views of most of these substances; which are no longer considered as simple, but compounds, and sometimes complexly compounded.

The following substances have, for a long time, been considered as compounds. Many of them are, undoubtedly, such: and not one of them, indeed, is perhaps simple. In the present state of our knowledge, indeed, it seems ridiculous for philosophers to talk of simple bodies. 1. *Volatile Oils*. These are found in almost every part of some plant or other. We more frequently meet with such oils in the vegetables of warm than of cold climates. But plants abounding in volatile oils, are to be met with in Labrador and in Terra Magellanica. 2. *Resins* insoluble in water and whose proper menstruum is alcohol, are found in the roots, in the stalks, the wood, and even in the blossoms, the fruit and seed of many plants. Such vegetables are, in general, more frequently met with in the warm than in the cold climates. Nay, even the same individual species is found to have a larger or smaller proportion of resinous matter, in proportion as it approaches to, or recedes from, the equatorial regions. We have a beautiful illustration of this observation in the Liquidambar Styraciflua, or Sweetgum already mentioned. 3. *Gum Resins*. These which are a compound of resinous and of gummous matter, are abundantly distributed through the vegetable kingdom. Such are Assafoetida, a valuable medicinal article, the produce of the Ferula Assafoetida, Gamboge, and many others, which are mentioned in various parts of this work. 4. *Camphor* was at one time, considered as a gum-resin; but is now deemed a peculiar principle. and is almost entirely insoluble in water. Camphor exists in many vegetables, and among others in the Laurus Camphora, L. Cinnamomum, L. Sassafras, L. Pseudo-Benzoin; and in many of the Verticillatæ. Dr. Roxburgh has informed me, by letter, that the genuine camphor is not the produce of the Laurus Camphora. The camphorate principle seems to be very congenial to vegetation. It proves a healthy stimulus to plants of various kinds, as I have shown by actual experiments. See *Transactions* of the Amer. Philos. Society vol. 4. art. xxvii See also, Willdenow's Principles, p. 394. 5. *Fixed* or *Fat Oils*. These exist in many vegetables; especially in their fruits. Such oily matter is especially abundant in the fruits of the Almond (Amygdalus communis,) the Walnuts and Hickories (Juglans regia, J. nigra, J. cinerea,) Live oak, the Olive (Olea Europea,) the Castor oil plant (Ricinus communis,) and many others. 6. *Wax* exists in and upon the fruits of many vegetables, such as the Laurus nobilis, the Myrica cerifera, &c. The leaves of some vegetables produce a pure wax, as the Carnauba of Brazil.—Ceroxylon Andicola.—It has been supposed to exist in the pollen of all flowers. 7. *Glutinous* and *Viscous Matter* exist in the berries of many plants, viz. the Misletoe, the different species of Smi-

lax, such as Smilax caduca, &c. Caouthouc is obtained from various vegetables, such as Siphonia elastica, Urceola elastica, &c. and I have discovered it, ready formed, in the berries of Smilax caduca, &c. See Tilloch's Philosophical Magazine, for July, 1812. 8. *Soapy Matter*. This, which is known for its useful quality of taking greasy spots out of linen, &c., occurs in the leaves of the Soap-wart (Saponaria officinalis,) in the fruit of the Sapindus Saponaria, in the roots of Æsculus Pavia, or Scarlet Pavia (See plate XV, with the explanation,) in many other roots, as those of Cichory, (Cichorium Intybus,) Burdock (Aretium,) &c. Quillai.* 9. Mucilage abounds in whole families of plants; thus rendering such plants very useful articles of diet or of medicine. We find it in the roots of the Marshmallow (Althæa officinalis,) in the stalks of the Goat's-thorn (Astragalus Creticus,) in the leaves of the Round-leaved Mallow (Malva rotundifolia,) and those of the Sassafras, in which it is very abundant, and totally free from the camphorate-like principle; in the seeds of the Quince, and most abundantly in the capsules and seeds of the Okra, or Hibiscus esculentus. We find it in the flowers of the Yellow or Common Mullein (Verbascum Thapsus.) 10. *Gum*, very nearly allied to mucilage, is also abundantly dispersed through the vegetable kingdom. It commonly exudes, in the form of globular masses, of different sizes, from the stems of certain trees, as the Damson-tree (Prunus domestica,) the Black-Cherry tree (P. avium,) and others. The stem of the Persimmon yields a fine gum; as do the leaves of the Agave Americana, or great flowering American Aloe.—Water is the proper menstruum of the gums, which are products both of the vegetable and of the animal kingdoms. The venom of the viper, of the different species of crotalus, or rattle snake, &c., is truly a gummous matter.

11. *Gluten*. This, which is said to compose the vegetable fibre, is a compound of carbon and of azote. 12. *Albumen*. This occurs in a very great number of culinary plants, and in the mealy seeds of some of the Tetradynamous plants. 13. *Starch* or *Amylum*, seems to consist of gluten, farina, and a saccharine mucilage. This is found in the seeds and roots of many plants, such as Æsculus Hippocastanum, and the American species of the same genus. The Potatoe, the Bryony (Bryonia alba,) and very many others. The American Indian Turnip, or Arum triphyllum, yields a beautiful and abundant amylum.

14. *Sugar* or *Saccharine Matter*, formerly called the saccharine principle. A great number of plants yield sugar, though, comparatively, but a few pure sugar. The purest sugar is found in the juice of the Sugar-Cane, (Saccharum officinarum, and some other species,) and in that of the Mays, or Indian corn. Various species of Acer, or Maple, especially the noble Acer saccharinum, or Sugar-Maple, yield an abundant quantity of sugar, which is obtained by tapping their boles, early in the months of February and March.—A single

* Quillaja Saponaria, *Molina*.

Birch-tree* has been known to yield in one season, of saccharine juice, sixty barrels. The roots of many plants furnish sugar such as the Beet (Beta vulgaris,) Parsnip, (Pastinaca sativa,) &c. Upon the whole, sugar is very extensively diffused through the vegetable world.—*Sugar* is a very compounded substance, consisting of oxygen, carbon, and hydrogen.

A Saccharine Matter, more nearly allied to the nature of honey, is prepared in the nectaries of a very great number of vegetables, as the Manna Ash, (Ornus europaea, &c.) Liquorice (Glycyrrhiza glabra,) Melianthus Major, &c. 15. *The bitter Principle*, or *Principium Amarum*, is very extensively diffused through the vegetable world: and it may be said to exist in every part of the vegetable fabric, not even excepting the *corculum*, or embryon. The following are some of the most bitter vegetables with which we are acquainted: viz. Common Worm-Wood (artemisia Absynthium,) Water-Trefoil (Menyanthes trifoliata,) European and North American Centaury (Chironia Centanrium and C. angularis,) different species of Quassia (Quassia amara, &c.,) American Columbo, or Frasera,† Hydrastis canadensis, &c. 16. *Narcotick Principle*, or *Principium Narcoticum*. This, which is well known for its remarkable effect in producing drowsiness, increased action of the heart and arteries (at least in its primary operation,) exhilaration, &c., is very often connected with the principle of bitterness, though, certainly, not necessarily so. It exists in many plants, as in the juice of Papaver somniferum, the seed of Sanguinaria Canadensis, in Atropa Belladonna, and other Luridæ; in Cherophyllum temulum, and other Umbellatæ; in Spigelia, and in many other plants. Some late writers chiefly of the chemical school, have imagined, that the narcotic principle, and the Prussic acid are the same. This is by no means a settled point.

17. *Acrid Principle*. This, which is less deserving of the name of a principle than many of the others, produces a certain pungent sensation which, however, doubtless, depends upon a combination of very different circumstances in different plants. Different species of Cochlearia, or Horse-Radish and Scurvy-grass; Arum Triphyllum, lately mentioned and other species; various species of Polygonum, Capsicum, Piper, Ranunculus, &c. 18. *Gallic Acid*. This exists in very many vegetables, especially in the roots and stalks. It was, at one time, supposed to constitute the principle of astringency in vegetables. The late Professor Woodhouse imagined that the astringency of vegetables is composed of this acid in union with alumine, already mentioned. 19. *Prussic Acid*. This has now been found in a good many plants, some of which are endowed with very active powers. In the leaves of Prunus Lauro-Cerasus, or the nefarious Cherry-Laurel; and in the flowers of the Peach. It also exists in the leaves of the North American

* Betula lanulosa:

† Frasera officinallis, *mihi;* Flora Virginica. Part 1. p. 49.

Prunus serotina, or Wild-Cherry;*—and in the root of Veronica virginica? 20. *Phosphoric Acid* has been found in several plants, but seldom in a free or detached state. The leaves of many trees contain it.

21. *Citric Acid.* This exists in the Lemon, the Gooseberry, the American Cranberry, Solanum Dulcamara, Physalis Pennsylvanica and many others. 22. *Malic Acid* occurs in the common Apple, the Quince, the Barberry, the Strawberry, &c. 23. *Oxalic Acid.* We find this in the different species of Oxalis, as Oxalis Acetosella, O. corniculata; in Rhubarb, in the American Sorrel tree (Andromeda arborea,) in the geranium acidum, and others. 24. *Acetic Acid* has been found in the sap of different trees. I have observed it in great abundance, in different North American Oaks, and in the Populus dilatata, or Lombardy Poplar. 25. *Tartaric Acid.* In the Tamarind, Agave Americana, and others. 26. *Benzoic Acid*, is found in Benzoin (Styrax Benzoe,) Balsam of Peru, Balsam of Tolu, Balsam Capævi, and others. 27. *Ammoniac*, or the volatile alkali, a compound consisting of azote and hydrogen, is obtained from many vegetables; as from certain Gramina, from many Tetradynamiæ, from some of the Luridæ, as Nux-vomica, &c. Some of the Neutral Salts are found in vegetables. Sulphate of Lime exists in a good many plants. Nitrate of magnesia exists in Indian corn, as Mirabelli has shown. Nitrate of Potash, or common nitre, in Borago officinalis, in Helianthus annuus, Mesembryanthemum crystallinum, Achillea Millefolium, Fumaria officinalis, and others. Sulphate of soda is found in the Tamarix gallica, and sodane in many sea-plants. Ocymum salinum, a plant of Chili, which is particularly mentioned by Molina, is said to furnish large quantities of the last mentioned article.—In the ashes of many vegetables, we detect the sulphate of potash or, vitriolated tartar. *Phosphates* of lime and potash have been detected in many vegetables; and in vegetables of opposite qualities. The first of these salts exist in the poisonous Aconitum Napellus and in most of the cerealia. Phosphate of potash is found in Barley, and in other grains. Different vegetables and among others the following contain malate of lime, or the malic acid; in union with lime: viz. Sempervivum tectorum, sedum album, S. acre, S. Telephium, and various species of Crassula and Mesembryanthemum; all plants of the Linnean order of Succulentae, formerly mentioned—Arum maculatum! Imperfect as are the preceding notices, they may be of some use to the student of botany and chemistry; and for him only are they intended.

The Sexual system of L. is founded, upon the beautiful doctrine of the Sexes of Plants. According to this system, all known plants are distributed into different Classes, Orders, Genera, Species, and Varieties. The classes are twenty-four in number, and are formed from the number, the place of insertion, the proportion, the connection, the disposition, or the absence of the stamens, or male organs of generation. The orders, or secondary divisions, are much more

numerous, and in the first thirteen classes are founded exclusively upon the number of the styles, or female organs. In the remaining eleven classes, they are founded upon other circumstances, the principal of which have, indeed, already been mentioned, but will be more advantageously explained, in the particular illustration of those orders.

CLASS I.—MONANDRIA.

The first class of the Sexual System is denominated Monandria. This term, like the names of all the classes, and most of the orders, of the Linnean system, is derived from the Greek language.* The class Monandria embraces all those plants which have hermaphrodite flowers, that is, male and female organs, contained within the same calyx or corolla; and only one stamen or anther. This class is subdivided into two orders, viz. Monogynia and Digynia.† These orders as has already been intimated, are formed from the number of the styles, or female organs. The plants of the first order have only one style, or female organ; those of the second have two.

Monogynia.—This order contains the following, among other, genera of plants, viz. Amomum, Renealmia, Curcuma, Thalia, Myrosma, Maranta, Kæmpferia, Canna, Alpinia, Costus, Boerhaavia, Hippuris, and Salicornia. Two species of the genus Valeriana, viz. Valeriana rubra and V. Calcitrapa, belong to this first order of Monandria.

Digynia.—This order is much less extensive than the first, and contains the following genera, viz. Corispermum, Callitriche, Blitum, Cinna, and Mniarum.

Character.—L. has not offered his Sexual System, as a Natural System. Nevertheless, we shall find, that some of the classes of this celebrated system are *nearly* natural, and that in others, various natural assemblages of plants may be found. The class of Monandria has no high claim to the character of a natural class. Indeed, it brings together vegetables of very unlike habits, or appearances, and of very opposite qualities. Hippuris and Salicornia, on the one hand, are very far removed from Canna and Amomum, on the other hand.

The class Monandria, however, contains a fine order of plants very nearly allied to each other, I mean the *Scitamineæ*, comprehending the Renealmia, Amomum, Curcuma, Thalia, Maranta, Myrosma, Kæmpferia, Canna, Alpinia, and Costus. Several of these plants have a most agreeable and highly aromatic taste, such as the Amomum Zingiber or ginger, Costus arabicus, the Kæmpferia Galanga, or Galangale, and others. Indeed, almost all these plants are more or less aromatic; and it is from this quality that they have received their name. *Scitamentum*, or *Scitum edulium*, signifies an etable which has a racy or

* Monandria, from μονος, one or alone; and ανηρ, a man or husband.
† Digynia, from δις, two, and a γυνη, woman or wife.

aromatic flavour. The Arrow-root, which is now introduced into the Materia Medica, is the produce of the Maranta arundinacea. The *Scitamineæ* constitute the eight of L's. *Ordines Naturales*, or Natural Orders.* The United States are far from being rich in plants of the class Monandria. Some fine species of Canna, however, are natives of this country. Salicornia, Callitriche, Blitum, and Cinna are also native genera. For an illustration of the class Monandria, see the eighth plate in these Elements.

CLASS II.—DIANDRIA.

The second class is denominated Diandria. This class contains those hermaphrodite flowers which are furnished with two stamens or male organs. It is more extensive than the first class, and is subdivided into three orders, viz. Monogynia, Digynia, and Trigynia.

Monogynia.—This first order, which is much the most extensive of the three, contains plants whose flowers are furnished with only one pistil, or female organ. The following genera belong to this order, viz. Olea, Chionanthus, Phillyrea, Ligustrum, Syringa, Eranthemum, Jasminum, Nyctanthes, Pæderota, Veronica, Gratiola, Schwenkia, Justicia, Dianthera, Calceolaria, Pinguicula, Utricularia, Wulfenia, Verbena, Lycopus, Amethystea, Ziziphora, Monarda, Rosmarinus, Salvia, Cunila; Collinsonia, Thouinia, Dialium, Morina, Circæa, Globba, and Ancistrum.

To this order belong also the following plants the genera of which are placed by L. in other classes of his system, viz. Valeriana Cornucopiæ, Boerhaavia diandra, B. Scandens, and B. erecta. The Bignonia Catalpa of L. may, in strict propriety be referred to this order, since only two of its filaments are furnished with anthers.—Professor Thunberg and those botanists who adopt the innovations which he has introduced into the Sexual System, have transferred into this order, several other genera, such as Ophrys, Arethusa, Serapias, Limodorum, and others, which will be particularly noticed in the classes *Gynandria*, &c.

Digynia.—The second order, Digynia, is said to contain only one plant, the anthoxanthum, which is a sweet-smelling grass, the flowers of which have two pistils, or female organs.

Trigynia.—Trigynia† is the name of the third order. This contains the genus Piper, or Pepper, of which there are many species. These have three pistils, or female organs.

Character.—The class Diandria, though not a natural class, embraces some assemblages of vegetables which are considerably allied to

* Caroli a Linne, M. D. Prælectiones in Ordines Naturales Plantarum. Eddit P. D. Giseke, M. D. p. 188.——275 Hamburgi: 1792.

† From τρεις, three.

one another. Such are Olea, Chionanthus, Ligustrum, Syringa,* &c. on the one hand; and on the other hand, a number of plants, with ringent flowers and naked seeds, such as Monarda, Rosmarinus, Salvia, &c. These last are considerably allied to the plants of the class *Didynamia,* to which, indeed some of them seem more properly to belong than to the class Diandria. In point of utility, the class Diandria is by no means unimportant. The Olea, or Olive, and the Piper, or Pepper, are employed both in diet and in medicine. Valuable medical qualities are ascribed to different species of Veronica, or Speedwell; Verbena, or vervain; not to mention the well-known qualities of the Rosmarinus, or Rosemary, and the Salvia, or Sage. The Monarda didyma (called in the United States, Mountain Balm, Oswego-tea, &c.) is much esteemed by the Oneidas, and other Indian tribes. Two native species of Cunila (Cunila mariana and C. pulegiodes) are deserving of a place in the materia medica. Collinsonia canadensis is said to possess invaluable medical qualities. Chionanthus, Phillyrea, Ligustrum, Syringa, Jasminum, &c. are beautiful or fragrant vegetables.

Of the genera which I have mentioned, the following are known to be natives of the United States, viz. Olea, Chionanthus, Veronica, Gratiola, Justicia, Pinguicula, Utricularia, Verbena, Lycopus, Monarda, Salvia, Cunila, Collinsonia, and Circæa. Anthoxanthum, though now extremely common, is not, I believe, a native. The Bignonia Catalpa is also a native. For an illustration of the class Diandria, See Plate IX.

CLASS III.—TRIANDRIA.

The third class is denominated Triandria. This class contains hermaphrodite flowers, that are furnished with three stamens, or male organs, and is subdivided into three orders, viz. Monogynia, Digynia, and Trigynia. These orders are formed from the number of the styles or female organs.

Monogynia.—This order contains the following, among other, genera, viz. Valeriana, Melothria, Crocus, Iris, Moræa, Antholyza, Gladiolus, Ixia, Dilatris, Wachendorfia, Commelina, Hippocratea, Loeflingia, Willichia, Tamarindus, Callisia, Rumphia, Cneorum, Xyris, Comocladia, Olax, Rotala, Ortegia, Polycnemum, Schoenus, Cyperus, Scirpus, Eriophorum, Nardus, Lygeum, Kyllingia, Fuirennia, and Pommereulla. Narcissus triandrus belongs to this order.

Digynia.—To this order belong the following genera, viz. Bobartia, Panicum, Cornucopiæ, Aristida, Alopecurus, Phleum, Muhlenbergia,

* These four genera, together with Nyctanthes, Jasminum, and some others, constitute L's. forty-fourth natural order, *Sepiariæ*, so named from *sepes*, a hedge, because some of them, on account of their size, elegance, &c. seem well adapted for the purpose of furniture for hedges.

Phalaris, Paspalum, Milium, Agrostis, Dactylis, Stipa, Lagurus, Saccharum, Aira, Melica, Uniola, Briza, Poa, Festuca, Bromus, Avena, Arundo, Anthistiria, Secale, Triticum, Rottboellia, Hordeum, Elymus, Lolium, and Cynosurus.

Trigynia.—This order contains the following genera, viz. Holosteum, Polycarpon, Lechea, Eriocaulon, Montia, Mollugo, Minuartia, Queria, Koenigia, Triplaris, and Proserpinaca.

Character.—This is, in various respects, a nautral class. The first order is less natural than the second. The genus Valeriana, or Valerian, is an irregular one, some of the species having only one, while others have three, and some four stamens. Iris, Crocus, Moræa, Antholyza, Gladiolus, Ixia, and some others, have considerable affinities to each other. They, together with Commelina, Tradescantia, Pontederia, &c. constitute L's. sixth order, called *Ensatæ*; a name given to them by the Sweedish naturalist, on account of the form of their leaves, which is thought to resemble that of a sword. This order likewise contains some grasses, such as Schoenus, Cyperus, &c. But the second order is almost entirely made up of plants of this family, many of which are highly important to mankind. The Sugar-cane is the Saccharum officinarum. The Avena, or Oat, the Secale, or Rye, the Triticum, or Wheat, the Hordeum, or Barley, not to mention others, are among the number of the most important vegetables with which we are acquainted. I have taken notice of some of the most essential characters of the grasses, in former parts of this work. Several of the plants of the third order of this class, are arranged by L. in his twenty-second natural order, the order *Caryophyllei*.

In a medical point of view, the class Triandria is much less important to mankind than several of the other classes of the system. Nevertheless, this class contains some useful articles of the materia medica (properly so called,) such as the Valeriana officinalis, or Valerian; the Crocus sativus, or Saffron; different species of Iris, or Flag; the "fever-cooling" Tamarind,* &c. Many of the genera of this class are natives of the United States. For an illustration of the class Triandria, see Plate X.

CLASS IV.—TETRANDRIA.

The fourth class is denominated Tetrandria.† This class contains hermaphrodite flowers, which are furnished with four stamens, or male organs, which are all of an uniform length. By this latter circumstance, the plants of the class Tetrandria are distinguished from those of the XIVth class, or Didynamia: for this last class comprehends plants that have also four stamens, two of which are long, and two short. See

* Thomson.

† From τεσσαρες, four.

Didynamia. The class Tetrandria is subdivided into three orders, viz. Monogynia, Digynia, and Tetragynia.

Monogynia.—This order contains the following genera, viz. Protea, Globularia, Hydrophylax, Cephalanthus, Dipsacus, Scabiosa, Knautia, Allionia, Aquartia, Callicarpa, Scoparia, Bartonia,* Centunculus, Plantago, Polypremum, Buddleia, Exacum, Penaea, Blaeria, Pavetta, Ixora, Petesia, Catesbaea, Mitchella, Hedyotis, Oldenlandia, Mannettia, Sanguisorba, Houstonia, Scabrita, Rubia, Galium, Asperula, Sherardia, Spermacoce, Knoxia, Diodia, Crucianella, Siphonanthus, Epimedium, Rhacoma, Ptelea, Samara, Fagara, Ammannia, Banksia, Hartogia, Trapa, Cissus, Cornus, Ludvigia, Santalum, Rivina, Camphorosma, Alchemilla, Dorstenia, Cometes, Sirium, Isnardia, and Elæagnus. To this order belong various species of plants, the genera of which are placed by L. in other classes of his system. I shall mention the following, viz. Valeriana Sibirica, Swertia corniculata, S. dichotoma, some species of Gentian and Euonymus, Coffea occidentalis, Peplis tetrandra, Cardamine hirsuta, Corchorus Coreta, Convallaria bifolia, Thesium alpinum, Melastoma tetrandrum, Hillia tetrandra, &c. &c.

Digynia.—This order contains the following genera, viz. Buffonia, Hypecoum, Hamamelis, Cuscuta, Aphanes, Cruzita, and Gomozia.

Tetragynia.—This order contains the following genera, viz. Ilex, Coldenia, Sagina, Tillæa, Myginda, Potamogeton, and Ruppia.

Character.—The class Tetrandria has some claim to the character of a natural class of plants. Several of the genera of the first order, such as Protea, Banksia, Globularia, Cephalanthus, Dipsacus, Scabiosa, &c. &c. form a part of L's. forty-eighth order, the order *Aggregatæ*. Protea, Banksia, Roupala, Brabeium, and Embothrium, constitute the order *Proteæ* in the learned system of Mr. De Jussieu. This is a very magnificent order of vegetables. Ixora, Hedyotis, Houstonia, Rubia, Galium, Asperula, Sherardia, Spermacoce, Knoxia, Diodia, Crucianella, Cornus, &c., from a part of L's forty-seventh natural order, *Stellatæ*. —All these genera, together with many others which L. has introduced as well into the fourth as into other classes of his sexual system, constitute an extensive order of vegetables, to which Mr. De Jussieu has given the name of *Rubiaceæ*. The class Tetrandria contains several plants that are entitled to the attention of physicians. The Rubia tinctorum, or common Madder, has been recommended in different diseases, particularly as an emmenagogue. Several species of Cornus, especially the Cornus florida, or Dogwood, and the Cornus sericea, called Red-willow, and Red-rod, have been found useful substitutes to the Peruvian bark, in the treatment of intermittent and other fevers. The bark is used. These are North American plants. The Dorstenia Contrayerva is the Contrayerva of the shops; an article, I think, of no great value. Some species of Ilex, or Holly, deserve to be farther investigated, particularly the Ilex vomitoria of Aiton. This which is the Yaupon, Yopon,

* Bartonia of Professor Willdenow.

Cusseena, or Cassena, of our Southern Indians, is a very powerful diuretic. It is also one of the most interesting Vegetable articles in the history of the American Indians. If there were no other reasons to believe, that the Americans, and certain Asiatics, particularly the Japanese and Chinese, were the children of a common stock, or family we should almost be led to adopt this opinion from an attention to the tradition of the Carolina Indians concerning the first discovery and use of the Cusseena.* Hamamelis virginica, or Witch-Hazel, is said to be one of the medicinal articles of the Indians, whose materia medica contains along with many active, and useful, very many inefficacious and worthless medicines. Cuscuta americana, or American Dodder, is employed to dye a yellow colour. Many of the genera of the class Tetrandria, are natives of the United States For an illustration of the class Tetrandria, see Plate X.

CLASS V.—PENTANDRIA.

The fifth class is denominated Pentandria.† It embraces these hermaphrodite flowers which are furnished with five stamens or male organs. The orders of this Class are six in number, and have received the following names, viz. Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, and Polyginia.

Monogynia.—This order is immensely numerous. I shall not attempt to enumerate the names of all the genera. Some of the principal of them shall be mentioned. They are the following, viz. Mirabilis, Plumbago, Cerinthe, Echium, Heliotropium, Pulmonaria, Lithospermum, Symphytum, Borago, Lycopsis, Asperugo, Cynoglossum, Anchusa, Myosotis, Hydrophyllum, Galax, Cortusa, Anagallis, Lysimachia, Cyclamen, Dodecatheon, Primula, Androsace, Aretia, Hottonia, Menyanthes, Spigelia, Ophiorhiza, Convolvulus, Datura, Hyoscyamus, Nicotiana, Verbascum, Chironia, Phlox, Polemonium, Ipomoea, Azalea, Nerium, Echites, Vinca, Tournefortia, Rauvolfia, Cestrum, Strychnos, Capsicum, Solanum, Physalis, Atropa, Ellisia, Lycium, Sideroxylon, Ignatia, Tektona, Samolus, Cinchona, Portlandia, Phyteuma, Campanula, Psychotria, Coffea, Gardenia, Genipa, Lonicera, Triosteum, Mussænda, Hamellia, Rhamnus, Ceanothus, Celastrus, Euonymus, Vitis, Mangifera, Cedrela, Diosma, Claytonia, Itea, Sauvagesia, Kuhnia, Ribes, Hedera, Heliconia, Cyrilla, Illecebrum, Glaux, Thesium.

To this order belong, also species of various other genera, which are arranged by L. in other classes of his system. I here mention a few of these species, referring to Willdenow and Persoon, for a more ample

* See my collections for an essay towards a Materia Medica of the United States. Second Edition, pages 56—58. Philadelphia: 1801. 8vo.

† From πεντε, five.

view,—Oldenlandia pentandra, Bartonia pentandra (*Flora Virginica,* &c. Part 1. p. 51,) several species of Cassia and Polygonum; Passerina pentandra; &c. &c.

Digynia.—This is also a very extensive order. It contains several of the Contortæ: fewer of them, however, than some writers have imagined; not one, indeed, in the list of Persoon.—It contains Chenopodium, Beta; the great and beautiful genus of Gentiana, some species of which belong to the fourth class.—Then follow a number of genera, belonging to the order of *Umbelliferæ.* A list of the principal genera I shall afterwards give, and their properties. At present I shall confine myself to some observations concerning their habit, structure, and places of growth. These Umbelliferæ have (generally) five superior petals, and two naked seeds, which when they have become ripe, are suspended, in a vertical direction, from the summit of a slender filiform receptacle. Some of the Umbelliferæ, however, have only one seed and one style: such as Lagœcia (L. cuminoides, referred here by Jussieu. In a preceding part of this work, I have spoken of the inflorescence of this vast family of plants, a knowledge of which is of great importance to the physician and the agriculturalist. I may now add, that in Eryngium, the *Umbella* is condensed into a *capitulum,* or scaly head, of a conical or globular form, showing its evident affinity with the Syngenesious compound flowers; and exhibiting, at the same time the habit of a Carduus, or Thistle, for which some of the species are often taken.

The greater number of the Umbelliferæ, are herbaceous plants. This order, however, contains some arborescent or at least frutescent species, such as Bupleurum arborescens, B. fruticosum, &c. These plants are very extensively dispersed over the earth; and in the most opposite soils; on high mountains, near the *niveau* of the ocean; in the driest and in the wettest ground. Yet few of the species, it is said are found in the hottest climates. Polygonum virginianum, Trianthema pentandra, Oldenlandia digyna, and several other species, belong to this second order.

Trigynia.—This order, though much less extensive than either of the two preceding, embraces, nevertheless, a considerable number of genera. The following are a few of them, viz. Rhus, Viburnum, Cassine, Sambucus, Staphylea, Tamarix, Turnera, and Sarothra. But the number of the stamens in some of these genera (especially Sambucus and Staphylea) is very indefinite.

Tetragynia.—Only two genera, Parnassia and Evolvulus, are referred to this order by L. and Willdenow, Evolvulus, of which several species are known, is closely allied to the genera Convolvulus, Ipomœa, &c., of the first order, and has lately been transferred by Persoon, to the order Digynia, next to Gentiana, Swertia, and Falkia.

Pentagynia.—The genera Aralia, Statice, Linum, Aldrovanda, Drosera, Gisekia, Crassula, and Sibbaldia, are referred to this order.—The number of the stamens in Aralia (Aralia nudicaulis, &c.) is very variable.

Polygynia.—The order Polygynia* contains the genus Myosurus, which is nearly allied to Ranunculus, in the class Polyandria. To this order also the genus Zanthorhiza† may be referred. But neither the stamens nor styles of this shrub are uniformly the same, in all specimens.

Character.—Of a class so immensely extensive as is the class Pentandria, it is extremely difficult to convey a correct character in the few words which I allot to the subject. The great order of *Asperifoliæ*, or Rough-leaved Plants, which constitute L's. forty-first order, belong to the first order of Pentandria. These Asperifoliæ, so named by Mr. Ray, because many of them are rough, being beset with hairs, are Echium, Heliotropium, Pulmonaria, Lithospermum, Onosma, Symphytum, Borago, Lycopsis, Asperugo, Cynoglossum, Anchusa, Myosotis: and some others. All the genera which I have mentioned, are introduced by Mr. De Jussieu into an order which the French botanist denominates *Borragineæ*. Datura, Hyoscyamus, Nicotiana, Verbascum, Cestrum, Strychnos, Capsicum, Solanum, Physalis, Atropa, Ellisia, Lycium, Ignatia, and some others, constitute a part of L's. twenty-eighth natural order, to which he has given the name of *Luridæ*.‡ This is a very natural order. Besides the plants which I have enumerated, it contains Digitalis and some other genera, which do not belong to the class Pentandria. It cannot be denied that some of these plants are somewhat ominous, or forbidding in their appearance. But I think this remark does not apply to Verbascum (Mullein,) or to Digitalis (Fox-glove.) Nor must it be supposed, that all the Luridæ are poisonous. The class Pentandria likewise contains a number of genera which constitute the thirtieth of L's natural orders, the order *Contortæ*.§ Rauvolfia, Pæderia, Carissa, Cerbera, Gardenia, Allamanda, Vinca, Nerium, Echites, Plumeria, Cameraria, Tabernæmontana, Ceropegia, Pergularia, Periploca, Cynanchum, Apocynum, Asclepias, and stapelia, are the principal plants in this order. Most of these genera belong to Mr. De Jussieu's natural order called *Apocineæ*. All these genera are furnished with that particular species of corolla which is called the *corolla torta*, or *contorta*, the twisted corolla. This has the edge of one petal lying over the next petal, in an oblique direction. It is observed, by L. that very few of these Contortæ are natives of Europe, whilst on the contrary, India abounds in them.|| North and South America are also rich in these species of plants. Some fine species of Cynanchum, Apocynum, and Asclepias are natives of the U. S. Many of the plants of the class Pen-

* Polygynia, from πολυς, many. † See Plate XII.

‡ *Luridæ*, from the Latin, *luridus*, pale, wan, livid, ghastly, dismal, &c. The Latin writers speak of lurid Acônite, lurid teeth, and the lurid border of the moon. Dr. Johnson says this word; which I cannot but think very expressive, is not used. It is, however, employed by Thomson, by Collins, and many other good writers.

§ *Contortæ*, from *contorqueo* to twist together.

|| Prælectiones, &c. p. 404.

tandria are highly important to mankind. Menyanthes, Spigelia, different species of Convolvulus (Convolvulus Jalapa, or Jallap,) Datura Stramonium or Jamestown-weed, Hyoscyamus (Henbane,) Nicotiana (Tobacco,) Chironia (Chironia augularis, called Centaury in the United States,) Solanum (Nightshade,) Atropa (Dwale,) Ignatia amara, or St. Ignatius's Bean, Cinchona (Cinchona officinalis, or Peruvian bark, &c.,) Psychotria emetica (Ipecacuanha,) Triosteum perfoliatum, Gentiana lutea, and other species, Heuchera americana (Alumn-root,) Conium maculatum (Hemlock,) Ferula Assafetida (Assafetida,) some species of Rhus, or Sumach, and several others, are all articles, and most of them important, of the Materia Medica. I am almost induced to assert, that, in a medical point of view, this is the most important class in the sexual system. But it must not be forgotten, that the Poppy, which furnishes us with opium, belongs to another class.—The great natural order of *Umbellatæ*, or Umbelliferous Plants (the forty-fifth order of L.) is entirely made up of Pentandrous vegetables. I shall here enumerate the principal vegetables of this order: Eryngium, Sanicula, Heracleum, Oenanthe, Caucalis, Artedia, Daucus, Laserpitium, Ammi, Hasselquistia, Conium, Bunium, Athamanta, Bupleurum, Sium, Cuminum, Ferula, Crithmum, Bubon, Ligusticum, Angelica, Sison, Æthusa, Coriandrum, Scandix, Chærophyllum, Phellandrium, Imperatoria, Seseli, Cicuta, Smyrnium, Carum, Thapsia, Pastinaca, Anethum, Apium, and Pimpinella. These vegetables enter into Mr. De Jussieu's order *Umbelliferæ*: the second order of his twelth class.

The genera Rhamnus, Ceanothus, Celastrus, Euonymus, Buttnera, Viburnum, Sambucus, Rhus, Cassine, and some other vegetables, both in this and in other classes, constitute L's. forty-third natural order, *Dumosæ*. The great naturalist asserts, that all these vegetables are endued with a malignant quality. It is true, that the greater number of the *Dumosæ* possess active or deleterious qualities; such are some species of Sideroxylon, Rhus, (Sumach,) Rhamnus (Buckthorn,) and others. Celastrus scandens is said to be an active vegetable. But it has not yet been proved, that all the *Dumosæ* possess the qualities ascribed to them by L. The fruit of the Callicarpa americana (which belongs to the fourth class) is esculent. The leaves of the Ceanothus americanus (New-Jersey-tea) have been found a good substitute for the teas of China and Japan, that are in general use. The fruit of some species of Viburnum are esculent, and entirely innocent, and we know not that a deleterious quality resides in other parts of these vegetables. Without entering further upon the consideration of this subject, it will be sufficient to observe, that no assemblage of vegetables, however natural, can be shown to possess one uniform assemblage of like properties. Nature seems to have been fond of introducing into her most active and deleterious families of plants, species and individuals that are innocent; and on the other hand, into her most inert and most innocent families, species and individuals possessed of active or poisonous qualities. Some of the *Umbellatæ* are extremely deleterous,

whilst others are altogether innocent. The same remark applies to the *Contortæ*, and to many other natural orders. A really natural arrangement of vegetables, by which I mean an arrangement that should bring together, under particular classes or orders, vegetables agreeing not only in their structure and appearance, but also in their properties, will never be accomplished. A belief, however, in this position ought not to deter us from industrious researches after a method much more natural than we yet possess. This should be the "ultimus finis Botanices." The United States abound in vegetables of the class Pentandria. Some of the genera of all the orders are natives of this great tract of country. Of some of those genera, the American species are very numerous. For an illustration of the class Pentandria, see Plate XI. See, also, Plate XXV.

CLASS VI.—HEXANDRIA.

The sixth class is denominated Hexandria.* It embraces those vegetables, whose flowers are furnished with six stamens. But the single circumstance of the number of their stamens is not sufficient to distinguish the plants of the class Hexandria. The plants of another hermaphrodite class, the class Tetradynamia, are also furnished with the same number of stamens. How, then, are we to distinguish these two classes from one another? By attending to the circumstance of the *proportion* of the stamens. In the class Hexandria, the stamens are all of one uniform length; or, at least, there is no determinate inequality in their lengths: but the plants of the class Tetradynamia have their stamens of unequal lengths, four of them being long, and two of them short. The class Hexandria is subdivided into five orders, viz. Monogynia, Digynia, Trigynia, Tetragynia, and Polygnia.

Monogynia.—This first order is the most numerous. It contains the following, among many other, genera, viz. Bromelia, Tillandsia, Burmannia, Lachenalia, Tradescantia, Berberis, Leontice, Hæmanthus, Leucojum, Galanthus, Narcissus, Pancratium, Amaryllis, Crinum, Pontederia, Bulbocodium, Allium, Hypoxis, Gethyllis, Hemerocallis, Agave, Aloe, Aletris, Polyanthes, Convallaria, Hyacinthus, Phormium, Asphodelus, Anthericum, Ornithogalum, Scilla, Cyanella, Dracæna, Asparagus, Gloriosa,† Erythronium, Uvularia, Bartonia,‡ Fritillaria, Lilium, Tulipa, Yucca, Albuca, Massonia, Orontium, Acorus, Calamus, Juncus, and Peplis.

Digynia.—This order contains the following genera, viz. Falkia, Atraphaxis, Gahnia, and Oryza.

Trigynia.—Colchicum, Melanthium, Medeola, Helonias, Triglochin, Rumex, and others belong to this order.

* From ἕξ, six. † Methonica of Jussieu.

‡ Bartonia of the late Mr. Humphrey Marshall.

Tetragynia.—This order contains the genus Petiveria, so named, by Plumier, in honour of Mr. James Petiver, an English naturalist, and collector.

Polygnia.—The genus Alisma belongs to this order.

Character.—The class Hexandria may, with safety, be characterized as one of the most beautiful in the sexual system. In the scale of importance, it also merits an higher place than several of the other classes. It has no inconsiderable claim to the character of a natural class. It, certainly, embraces some pretty extensive natural assemblages, such are those which L. has thrown into his ninth and tenth orders, *Spathaceæ* and *Coronariæ*, of which I have already made mention. The following are some of the genera which constitute L's. eleventh order or *Sarmentaceæ*:* Alstroemeria, Convallaria, Dracæna, Asparagus, Gloriosa, Erythronium, Uvularia, Medeola, Trillium, and others. L. asserts, that all his *Sarmentaceæ*, with the exception of two, viz. Dioscorea (which belongs to the XXII. class) and Asparagus, have something malignant in their composition.† Gloriosa is, indeed, a very poisonous plant; and nearly the same remark may be applied to several others. But the order of which I am speaking contains several plants, that appear to be entirely innocent. The young shoots of a species of Convallaria (called Wild-Asparagus) are eaten in some parts of the United-States, and are deemed little inferior to Asparagus. The root of the Medeola virginica is eaten by our Indians. This plant is called "Indian Cucumber."

The class Hexandria has given to the materia medica some important or useful vegetables. Different species of Allium, particularly the Allium sativum, or Garlick, and the Allium Porrum, or Leek, though more employed as articles of diet, are, unquestionably, possessed of very useful medical qualities. The aloes of the shops is the inspissated juice of different species of Aloe. That important diuretic, the Squill, is the bulb or root of the Scilla maritima. The bulbous root of the Colchicum autumnale, or Meadow-Saffron, is possessed of the same powers, but in a less eminent degree. I must not omit to mention the Oryza sativa, or Rice, though this is not strictly a medicinal article. This plant alone gives to the class Hexandria a high importance. But how greatly is it to be regretted, that this vegetable, in the most free and happy country upon earth, should be cultivated, almost exclusively, by the hands of slaves! Shall we never learn to be just to our fellow creatures? Shall we blindly pursue the imaginary advantages of the moment, and neglect the still but solemn voice of God, until

——"Vengeance in the lurid air,
"Lifts her red arm, expos'd and bare."

* I have already made mention of the *caulis sarmentosus*, or sarmentose stem; so called from *sarmentum*, the twig or spray of a vine. Several of the

† Prælectiones, &c. p. 304.

Beside the plants which I have mentioned, it is said that Leontice Thalictroides* and some species of Prinos possess active medical qualities. I repose no manner of confidence in the powers that have been ascribed to the bulb of Hypoxis erecta, as a remedy against the bite of the rattle-snake, and other venomous serpents. The United States are remarkably rich in plants of the class Hexandria. See Plates XIII. and XIV., for illustrations of this class.

CLASS VII.—HEPTANDRIA.

The class Heptandria† embraces those hermaphrodite vegetables whose flowers are furnished with seven stamens, or male organs. This class, the most inconsiderable of the twenty-four, is subdivided into four orders, viz. Monogynia, Digynia, Tetragynia, and Heptagynia.

Monogynia.—Trientalis,‡ Disandra, Pisonia, Tovaria, Petiveria, Pancovia, Æsculus, Petrocarya, and Jonesia, are referred to this order by some of the latest botanists: among others by Persoon.—It may be doubted, however, whether any of these genera be invariably heptandrous.§

Digynia.—Limeum, an African genus, of which three species are known, is placed here.

Tetragynia.—Aponogeton was formerly placed here. Smith says it "is now properly removed to Dodecandria." But Persoon has referred it to Hexandria Trigynia: yet he says the stamens are from seven to thirteen in number! This writer retains here Saururus, which, however, is really of the sixth class: and also Astranthus, a genus of Cochinchina, the stamens of which are said by Loureiro to be very generally seven in number; though sometimes six and eight.‖

Heptagynia.—The genus Septas, a very singular genus, belongs to this order. The calyx of this plant consists of seven parts, there are seven petals, seven germs, and seven capsules!! Only one species of this genus is known, the septas capensis, a native of the Cape of Good-Hope.

vegetables of the order Sarmentaceae, such as Smilaz, Dioscorea, Tamus, Menispermum, Cissampelos, are furnished with this species of stem: but others (I believe the greater number) have stems of another kind. The order Sarmentaceæ is far from being a very natural assemblage of vegetables.

* A native of Pennsylvania, &c. † From ἑπτα, seven.

‡ "A favorite plant of L." Smith

§ In Trientalis, the stamens are five, six, and seven in number. Disandra has from five to eight: Pisonia most commonly six, less frequently from five to eight, of these organs. Of Tovaria, a Peruvian plant, I know nothing, In Petiveria, which has already been mentioned, the stamens are from six to eight. The stamens in the different species of Æsculus vary in number remarkably: they are, perhaps, more frequently six and eight than seven.—Petrocarya is said to have fourteen stamens, seven of which are sterile.

‖ Flora Cochinchinensis, tom. i. p. 222.

Character.—The class Heptandria has no manner of claim to the character of a natural class. No two of the genera which it contains are arranged by L. in any one of his natural orders. No two of them, if we except Saururus and Aponogeton belong to any one of Jussieu's orders. These two genera belong to the order *Naiades* in the system of the French botanist.—Of the properties of the vegetables of this class, I can say but little. The bark of the Æsculus Hippocastanum,—which now flourishes nearly as well in many parts of the United States as upon its native pindus,—is said* to be a good substitute for the Peruvian bark, in the cure of intermittents. The nut of Æsculus flava and the bark of the root of Æsculus Pavia contain a noxious principle. (See the explanation of Plate XV.) Saururus, called in the United States, Swamp-lillies, is arranged by L. in his natural order, to which he has given the name of *Piperitæ*, from the genus Piper, which belongs to it. The Sweedish naturalist informs us, that these *Piperitæ* are all acrid plants, that when externally applied, they are rubifacients, &c. Saururus, however, is a very mild plant, and is often used in the shape of poultices, by the people of the United States! Of the Heptandrous plants which I have mentioned, Trientalis, Æsculus, and Saururus are natives of the United States. For an illustration of the class Heptandria, see Plate XV.

CLASS VIII.—OCTANDRIA.

The eighth class is denominated Octandria.†—It embraces those hermaphrodite flowers which are furnished with eight stamens, or male organs. This class is subdivided into four orders, viz. Monogynia, Digynia, Trigynia, and Tetragynia.

Monogynia.—To this order belong the following genera, viz. Mimusops, Tropæolum, Combretum, Epilobium, Gaura, Oenothera, Rhexia, Osbeckia, Jambolifera, Lawsonia, Melicocca, Amyris, Fuchsia, Chlora, Vaccinium, Erica, Menziesia, Gnidia, Dirca, Daphne, Passerina, &c. The following species of genera, which are arranged by L. in other classes, belong to this order: viz. Monotropa Hipopithys, Ruta graveolens, Jussieua erecta, J. fuffruticosa, Portulaca quadrifida, Dais octandra, Fagara octandra, Melastoma octandrum, Elais serrata, Rivinia octandra, Andromeda octandra, Capparis ferruginea, Breynia Quivisia, several species of Samyda, not to mention many others!!

Digynia.—Litchi, Weinmannia, Moehringia, Codia, Schmiedelia, and Galenia, belong to this order.

Trigynia.—Paullinia, Cardiospermum, Sapindus, Ornitrophe, Ponaea, Coccoloba, and Polygonum. The last is an irregular or variable genus, the different species (according to the number of their

* By Dr. Cusson, of Montpelier, and others.
† From οκτω, eight.

stamens and styles) arranging under different classes and orders of the system.

Tetragynia.—Adoxa, Elatine, Paris, and Haloragis (and frequently Myriophyllum) belong to this order.

Character.—The class Octandria embraces several natural assemblages of vegetables. Epilobium, Gaura, Oenothera, Rhexia, and Osbeckia, form a part of L's. seventeenth natural order, *Calycanthemæ*.* These plants, among other characters, have the corolla and the stamens inserted into the calyx. The Vaccinium, or Whortle-berry: and the immense family of Erica, or Heath, are placed by L. in his eighteenth order, *Bicornes*,† so called because in many of the plants of this order, the anthers have the appearance of two horns.‡ Mr. De Jussieu's order *Ericæ* comprehends the genera Erica, Vaccinium, and several of L's. Decandrous vegetables, which are afterwards to be mentioned; and some genera belonging to neither Octandria nor Decandria. Gnidia, Dirca, Daphne, Passerina, and some others, form L's. thirty-first order. *Vepreculæ*.§ Paris belongs to the order Sarmentaceæ. Elatine, together with Hippuris, Proserpinaca, and several others, constitute L's. fifteenth order, *Inundatæ*. These plants grow naturally in the water.

We know but little of the medical properties of the plants of this class. Their other properties are better investigated. The fruits of various species of Vaccinium, comprehending the Whortle-berries and Cranberries, are esculent and wholesome. To some constitutions, however, some of the Whortle-berries are disagreeable. The common American Cranberry (Vaccinium macrocarpon of Aiton) is an important vegetable, on account of its fine acid fruit. The buds of Tropæolum make a good pickle. Different species of Polygonum, particularly the Polygonum Fagopyrum (Buck-wheat,) and the Polygonum tataricum, furnish us with a very nutritious and agreeable article of diet. The first of these vegetables is much cultivated, and the last should be cultivated in the United States. The pulverized leaves of the Lawsonia inermis (which the Arabs call *Henna*, or *Alhenna*) are much used by the Egyptians, Persians, and other people of Africa and Asia, to dye the nails of their hands and feet of a yellow colour. In Egypt, this practice appears to have been of a very ancient date. The flowers of the Lawsonia have that peculiar animal smell which I formerly hinted at. The gum Elemi of the shops is supposed to be the produce of the Amyris Elemifera, a native of Carolina. The Opobálsamum, or Balsam of Mecca; is obtained from another species, the Amyris Opobalsamum. Different species of Daphne, particularly

* *Calycanthemae*, from calyx, the flower-cup, ανθος, the flower.

† *Bicornes*, from *bis*, twice, *cornu*, a horn.

‡ Of this order, I shall take further notice, in treating of the class Decandria.

§ *Vepreculæ*, from *vepres*, a brier.

Daphne Mezereum and D. Gnidium, are important articles in the materia medica, and perhaps too much neglected. Dirca is said to be used as a cathartic.* The root of Paris quadrifolia is emetic, and it is thought may be substituted for ipecacuanha. Useful medical qualities are ascribed to Oenothera biennis: but of these qualities I can say nothing, from my own experience.

Of the genera which I have mentioned, the following are known to be natives of the United States: Epilobium, Gaura, Oenothera, Rhexia, Chlora, Vaccinium, Menziesia, Dirca, and Polygonum. Not a single species of Erica is to be met with in this great tract of country! But in place of "the blooming Heather," nature has liberally supplied our country with various species of Andromeda, Vaccinium, not to mention other genera, which are nearly allied to Erica. The Hudsonia ericoides (one of Jussieu's *Ericæ*) is extremely common in many parts of the United-States, and has greatly the *facies*, or aspect of an Heath. For an illustration of this class, see Plate XVI.

CLASS IX.—ENNEANDRIA.

Enneandria† is the name of the ninth class. This class contains those hermaphrodite flowers which are furnished with nine stamens, or male organs, and is subdivided into three orders, vix. Monogynia, Trigynia, and Hexagynia.

Monogynia.—Tinus, Laurus, Anacardium, Panke, Volutella, Ginannia, and Cassyta belong to this order.

Trigynia.—This order contains the important genus, Rheum, or Rhubarb, of which several species are known to the botanist.

Hexagynia.—The genus Butomus, or Flowering Rush, belongs to this order.

Character.—With respect to the genera which belong to the class Enneandria, they constitute different assemblages of vegetables more or less natural. Laurus, Anacardium, Rheum, together with Callitriche, Blitum, Corispermum, Rumex, Polygonum, and several others, which have already been mentioned, as belonging to preceding classes; and also, certain genera which are arranged in the succeeding classes, constitute L's. twelth order, *Holoraceæ*,‡ which I do not think entitled to the name of a natural order. The genus Laurus gives name to an order in the system of Mr. De Jussieu. It is the fourth order of his sixth class. In the system of the same learned naturalist, there is an order entitled *Polygoneæ*, which embraces one of the genera of the class

* See collections for a Materia Medica, &c. p, 31. See, also, p. 22.

† Enneandria, from ἐννέα, nine.

‡ *Holoraceæ* or *Holeraceae*, more commonly written *Oleraceae*, from *olus*, or *holus*, a pot-herb. Several of the genera of this order are arranged by Jussieu in his order, *Atriplices*.

Enneandria; the genus Rheum. Butomus, together with Calamus, Juncus, Triglochin, and some others, belong to L's. fifth order, *Tripetaloideæ.**

The class Enneandria, though a very small class, contains a number of important vegetables. Different species of Laurus are highly important for medical or domestic purposes. Camphor is the produce of the Laurus Camphora, Cinnamon of the Laurus Cinnamomum, and Cassia of the Laurus Cassia. To the Laurus Benzoin, the people of the United States have ascribed useful medical powers. The Laurus Sassafras, or Sassafras, is entitled to the attention of physicians. The leaves of the Laurus Borbonia are used as a spice, in some parts of the United States. The Laurus nobilis, which the Greeks called Δαφνη, is the species which was dedicated to Apollo, and employed as a crown or garland for the heads of Roman emperors, pontiffs and poets. The different species of Rhubarb are valuable cathartics, particularly the Rheum palmatum, or Palmated Rhubarb. I think it not improbable, that North America possesses some native species of this genus. Be this as it may, the cultivation of Rhubarb ought to be attended to in the United States. The United States possess few plants of the class Enneandria. It is true, that several species of Laurus are natives of this great tract of country: but our species are by no means constantly furnished with nine stamens. Thus, Laurus Sassafras is sometimes found dioicous, and Laurus Borbonia belongs to Decandria. For an illustration of the class Enneandria, see Plate XVI.

CLASS X.—DECANDRIA.

The tenth class is denominated Decandria.† It contains those hermaphrodite flowers which are furnished with ten stamens, or male organs. But this circumstance alone is not sufficient to distinguish the plants of the class Decandria from all the other classes of hermaphrodite vegetables. Other circumstances, or characters, which will be particularly attended to in treating of the classes Monadelphia, Diadelphia, Syngenesia, and Gynandria, must be carefully attended to. It is proper, however, to observe, in this place that in order to constitute a pure Decandrous plant, it is necessary that the ten stamens be distinct from each other, that is, not united together either by their filaments below, or by their anthers above.‡

* From *tres*, three, and *petalum*, a petal; because several of the genera have three petals. See Monoecia. † From δεκα, ten.

‡ Milne and other writers inform us, that the stamens of the plants of the class Decandria, must be of an equal length. But this circumstance is of little or no consequence in investigating the Decandrous plants, many of which have their stamens of unequal lengths, such as Rhododendron Rhodora, &c.

The class decandria is subdivided into six orders. These orders like all the orders of the preceding nine classes; and of the three succeeding classes, are formed from the circumstance of the number of the styles, or female organs. The orders are *Monogynia*, *Digynia*, *Trigynia*, *Tetragynia*, *Pentagynia*, and *Decagynia*.

Monogynia.—The first order is by far the most extensive of the whole. The following are a few of the genera which it contains: Sophora, Podalyria, Anagyris, Cercis, Bauhinia, Poinciana, Myroxylon, Parkinsonia, Cæsalpinia, Toluifera, Cassia, Guilandina, Dictamnus, Adenanthera, Hæmatoxylum, Melia, Swietenia, Guajacum, Ruta, Zygophyllum, Quassia, Limonia, Monotropa, Clethra, Pyrola, Ledum, Dionæa, Melastoma, Andromeda, Rhododendron, Kalmia, Rhodora, Epigæa, Gaultheria, Arbutus, Styrax, Inocarpus, Cassuvium, Samyda, Copaifera, and others.*

Digynia.—The second order contains the following genera: viz. Scleranthus, Trianthema, Chrysosplenium, Hydrangea, Saxifraga, Tiarella, Mitella, Cunonia, Saponaria, Dianthus, &c.

Trigynia.—Cucubalus, Silene, Stellaria, Arenaria, Malpighia, Banisteria, and others belong to this order.

Pentagynia.—Averrhoa, Spondias, Cotyledon, Sedum, Penthorum, Bergia, Oxalis, Agrostemma, Lychnis, Cerastium, and Spergula, belong to this order. Some species of Oxalis belong to the XVIth class. One species of Lychnis (Lychnis dioica) belongs to the XXIId class. Lychnis alpina and L. quadridentata have often only four styles.

Decagynia.—This is the most inconsiderable order of the whole. It contains the genera Neurada and Phytolacca. The latter is a very irregular genus. The species which causes the genus to be arranged in the present order is the P. decandria, or Common Poke. A second species belongs to the VIIIth class; a third to XIIth, and a fourth to the XXIId class

Character.—At the very head of this great class, we find Sophora, Anagyris, and some other genera, which belong to L's. thirty second order, *Papilionaceæ*, of which I shall make more particular mention, when treating of the plants of the XVIIth class. Cercis, Bauhinia, Hymenæa, Poinciana, Myroxylon, Parkinsonia, Cæsalbinia, Cassia, Guilandina, Adenanthera, Hæmatoxylum, and some others belong to the thirty-third order, *Lomentaceæ*,† so called because several of the genera which it embraces furnish fine tinctures that are used in dying. Such are different species of Cæsalpinia, or Braisiletto; the Guilandina Moringa, the wood of which dies a fine blue colour; Hæmatoxylum Campechianum, called Log-wood, or Campeachy-wood, &c. Melia, Swietenia, Malpighia, Banisteria, together with

* The genera Rhododendron, Kalmia, Rhodora, and Ledum are the Decandrous plants of Jussieu's order *Rhododendra*. Azalea and Itea (Pentandrous plants,) Menziesia (of the class Octandria,) and Befaria (of the class Dodecandria) belong to the same fine order.

† *Lomentaceæ*, from *lomentum*, a colour used by painters.

Æsculus, and Tropæolum, and some other genera, which have already been mentioned in treating of preceding classses, belong to the twenty third of L's. natural orders, the order *Trihilatæ.** Guajacum, Tribulus, Fagonia, Zygophyllum, Quassia, Dionæa, Oxalis, Averrhoa, and others, belong to the order *Gruinales*, which will be more particularly noticed when treating of the XVIth class. Clethra, Pyrola, Ledum, Andromeda, Rhododendron, Kalmia, Epigæa, Gaultherca, Arbutus, Styrax, together with Azalea, Vaccinium, Erica, and others, which are afterwards to be mentioned, constitute the order Bicornes. I have already made some mention of this order. L. asserts, that there is no poisonous plant in the order Bicornes, unless, perhaps, the genus Ledum.† Aliquando Bonus Dormitat Homerus. Some of the Bicornes are very poisonous vegetables, such are Kalmia latifolia and angustifolia, some species of Azalea, Andromeda, &c. Epigæa repens is said to be poisonous to sheep. Gaultheria is not an inert plant. I can say nothing certain concerning Clethra and Rhodora. I shall have occasion to speak of the properties of other Bicornes when treating of the sexual classes to which they belong. From several of the plants of this order, bees obtain an abundance of honey, which in some species, is endued with a noxious quality. L. is. certainly, incorrect, when he asserts, that Kalmia is the only genus among the Bicornes, that is furnished with nectaries. Gaultheria procumbens, not to mention others, has these parts. Hydrangea, Chrysospleniun, Saxifraga, Tiarella, Mitella, Cotyledon, Sedum, Penthorum, Bergia, together with Heuchera, formerly mentioned, and several others, which will be noticed in their proper places, belong to L's. thirteenth natural order, *Succulentæ*‡ or Succulent Plants. It must not however, be supposed, that all the plants of this order are succulent, or especially juicy. Heuchera is far from being succulent. The same remark may be extended to Nymphæa, Saracenia, and others. Several of L's. Succulentæ belong to Mr. De Jussieu's order Saxifragæ. The class Decandria contains a beautiful tribe of vegetables, which constitute L's. twenty-second natural order, *Caryophyllei*, formerly mentioned. This is a pretty extensive tribe of plants. Besides the Triandrous and Tetrandrous genera which it contains, the following Decandrous genera belong to it: viz. Gypsophila, Saponaria, Dianthus, Arenaria, Stellaria, Cucubalus, Silene, Spergula, Cerastium, Agrostemma, Lychnis, and others. Most of these genera belong to Jussieu's

* *Trihilatæ*, from *tres*, three, and hilum, the eye, or external scar of the seed already mentioned. Several of the vegetables of this order have three seeds, which are distinctly marked with an external cicatrix, or scar, where they are fastened within the fruit.

† "Vix quicquam Olidi continet ulla totius ordinis, excepto Ledo, nec ulla venenata est, nisi idem forte Ledum, quod tamen incertum adhuc est." Prælectiones, &c. p. 343.

‡ *Succulentæ*, from *succus*, juice.

order, *Caryophylleæ.* In a medical point of view, the class Decandria is by no means unimportant. That valuable medicine, the gum-resin Guaiacum, is the produce of the Guajacum officinale. The Toluifera Balsamum furnishes us with the Balsam of Tolu, the Copaifera officinalis with the Balsam of Capaevi, and the Myroxylon peruiferum with the Balsam of Peru. These four vegetables are natives of America, but are not known to be indigenous within the limits of the United States. The Senna of the shops is the produce of the Cassia Senna. The leaves of some of the American species may be substituted for this. The bark of Swietenia febrifuga, of Roxburgh, has been found an excellent substitute for the Peruvian bark. The Melia Azedarach is an invaluable anthelmintic.* Different species of Quassia, particularly the Simaruba and amara, are some of the most powerful bitter tonics of the materia medica. Kalmia latifolia and angustifolia, though hitherto scarcely employed by physicians, promise to be useful medicines, in a variety of cases. Of the former species I can speak from experience.† Rhododendron Chrysanthum has a place in some of the European Pharmacopoeias. The Arbutus Uva ursi should be in the hands of every physician. Different species of Pyrola have been employed by physicians. To the Pyrola umbellata (Pippsissewa) great virtues are ascribed, in some parts of the United States. The Benzoin of the shops, which for a long time, was supposed to be the produce of the Laurus Benzoin, formerly mentioned, is now ascertained to be the produce of a species of Styrax, the Syrax Benzoe. Silene virginica is said to possess the powers of an anthelmintic. Phytolacca decandra is, unquestionably, an article entitled to the attention of physicians.‡

Many of the genera of the class Decandria are natives of the United States. This tract of country is especially rich in plants of the fine order Bicornes.

For an illustration of the class, see Plate XVII.

CLASS XI.—DODECANDRIA.

The twelth class is named Dodecandria.§ This class contains plants with hermaphrodite flowers, which, agreeably to the name of the class, ought to have twelve stamens or male organs. It must not, however, be supposed that all the plants of this class have the precise

* See Dr. Duvall's Inaugural Dissertation. Philadelphia: 1802.

† See Dr. Thomas's Inaugural Dissertation. Pailadelphia: 1802.

‡ For some information concerning the medical properties of several North American vegetables belonging to the class Decandria, see different parts of my *Collections for an essay towards a Materia Medica*, &c. See, also, Transactions of the American Philosophical Society, Vol. V. No. vii.

§ From δωδεκα, twelve.

number of stamens which the name imports. Several of the genera have more than twelve of these sexual organs; and some of them have even less than the implied number. Thus, Bocconia has from eight to twelve, or more; Hudsonia from ten to fifteen (generally ten, rarely more than twelve;) Befaria fourteen; Peganum, Nitraria, and others, fifteen; and Garcinia and Bassia, sixteen, stamens. Several of the genera have nineteen stamens, and Agrimonia has from twelve to twenty. So indeterminate is the number of the stamens of this class!

According to L. the class in question embraces those hermaphrodite vegetables, whose flowers have from twelve to nineteen stamens, or male organs. But this is not the essential feature of the class Dodecandria. It seems to be the essential character of this class, that the stamens (or in place of them the anthers,) whatever may be their precise number, are inserted into the receptaculum, or receptacle. *By the place of insertion*, we very readily distinguish the plants of the class Dodecandria from those of Icosandria: for in this last the stamens are inserted either into the calyx or into the petals. But it is not so easy to distinguish the plants of Dodecandria from those of Polyandria. In both, the insertion of the stamens is the same, and we shall afterwards see, that there are not a few of the plants of Polyandria which have less than nineteen or even twelve stamens.*

From this view of the subject, it must appear evident, that the class Dodecandria opposes a considerable difficulty to the student, in his investigation of plants, according to the principles of the sexual method. Were we to adopt the Linnæan interpretation of the class, we should rob the class Polyandria of some of its genera, and associate them with the plants of Dodecandria, with which they have much less affinity, in their general aspect, and in properties. I cannot help thinking the class Dodecandria a very exceptionable one: nor am I singular in this opinion. The learned Crantz and other writers have long ago, entertained a similar opinion. Would the sexual system suffer any injury by the total abolition of this class? I think it would not. But where should we dispose of the genera which are now arranged under this class? In different classes, according to the number, insertion, &c. of the stamens. All those genera, which have more than ten stamens, might be thrown into the class Polyandria. See Polyandria.

The class Dodecandria is subdivided into five orders, viz. Monogynia, Digynia, Trigynia, Pentagynia, and Dodecagynia.

Monogynia.—This is the most numerous order. It embraces the following, among other genera, viz. Bocconia, Hudsonia, Asarum, Rhizopnora, Garcinia, Cratæva, Halesia, Canella, Triumfetta, Peganum, Nitraria, Portulaca, Lythrum, Cuphea, and Decumaria.

* Among other writers, Dr. Martyn (*The Language of Botany, &c.*) misleads the student by asserting, that the class Dodecandria comprehends, "all those plants which have hermaphrodite flowers with from twelve to nineteen stamens inclusive."

Digynia.—Heliocarpus and Agrimonia are referred to this order. But the latter genus should, I think, be placed in the class Icosandria.

Trigynia.—Reseda, the vast genus Euphorbia, visnea, Tacca, Pallasia, and others, belong to this order.

Pentagynia.—The two genera Glinus and Blackwellia are referred to this order.

Dodecagynia.—The genera Sempervivum and Gastonia belong to this order.

Character.—It cannot be asserted, that the class Dodecandria is a natural class. The different genera which it contains have very little natural affinity to each other. Asarum is referred to the order Sarmentaceæ; Garcinia and Halesia to the order Bicornes; Lythrum to Calycanthemæ; Portulaca and Sempervivum to Succulentæ. Triumfetta, and Heliocarpus belong to the thirty-seventh of L's. natural orders, the order *Columniferæ*, which will be more particularly considered afterwards. Euphorbia, with a number of other genera, belongs to L's. thirty-eighth order, *Tricoccæ*. In the system of Mr. De Jussieu, the genus Euphorbia gives name to a particular order, *Euphorbiæ*.

Few of the classes of the sexual system are of so little cosequence to mankind, in a medical point of view as the class of which I am speaking. Some of the plants, however, which it embraces, are endued with useful medical properties. Different species of Asarum, or Asarabacca, are employed as sternutatories, and as emetics. The leaves of Asarum europæum, or Common Asarabacca, constitute the basis of the *pulvis sternutatorius* of some of the foreign Pharmacopoeias. Asarum, canadense, very improperly called Coltsfoot, is sold in the market of Philadelphia, as a remedy, for hooping-cough. The root of this species has an agreeable aromatic taste: hence one of the more common names of this plant, Wild-Ginger. The Canella alba of the shops is the bark of a West-Indian vegetable of the same name. Lythrum Salicaria has been recommended* as a remedy in dysenteries. Different species of Euphorbia, or Spurge, are employed in medical practice. It was, at one time supposed, that the Ipecacuanha of the shops is the root of Euphorbia Ipecacuanhæ. But it is now ascertained, that the most useful of the vegetable emetics is the root of a Pentandrous plant, which was formerly mentioned. Euphorbia Ipecacuanhæ is, however, employed as an emetic, in some parts of the United States. As to Agrimonia Eupatoria, or agrimony, which was once a celebrated remedy, I believe few persons, nowadays, repose much confidence in it, notwithstanding the high encomiums which it received from that singular and multifarious character, Sir John Hill. Of the genera which I have mentioned, the following are known to be natives of the United States: viz. Hudsonia, Asarum, Halesia, Decumaria, Triumfetta, Portulaca, Lythrum, Cuphea, Agrimonia, and Euphorbia. For an illustration of the class Dodecandria, see Plate XXX.

* By Threlkeld, De Haen, and other writers.

CLASS XII.—ICOSANDRIA.

The twelth class is denominated Icosandria.* This class embraces those Hermaphrodite flowers which are furnished with twenty or more stamens, which are inserted into the calyx, or into the inner side of the petals. By this last mentioned circumstance, and not by the mere number of the stamens, is the class Icosandria distinguished from the class Polyandria, which is next to be treated of. Many Polyandrous plants are not furnished with more stamens than the plants of the class Icosandria. On the contrary, we shall afterwards see, that not a few of the genera which L. has arranged in the XIIIth class of his system, have constantly less than twenty stamens. Here, then, we once more enter into a region of difficulty with respect to the discrimination of the classical characters of the universally received system of L. How are the classes Icosandria and Polyandria to be distinguished from each other? I have just said, that in the plants of the class Icosandria, the stamens whatever may be their number, are inserted into the calyx, or into the sides of the petals. But in the plants of the class Polyandria, the stamens are inserted into the receptaculum, or receptacle of the flower. This is a nice and very interesting character in the discrimination of these two classes. We shall afterwards see how important and how necessary to be attended to, it is in our endeavours to investigate the properties of Icosandrous and Polyandrous plants.—There is still another character by which the class Icosandria may be distinguished from Polyandria. The plants of Icosandria have a concave calyx, or flower–cup, which is composed of one leaf, to the inner side of which the petals are fastened by their ungues, or claws. "To confound this class with Polyandria is abominable."† See Polyandria.

The class Icosandria is subdivided into five orders, viz. Monogynia, Digynia, Trigynia, Pentagynia, and Polygynia.

Monogynia.—This first order contains the following genera, viz. Cactus, Eugenia, Philadelphus, Leptospermum, Fabricia, Metrosideros, Psidium, Myrtus, Punica, Robinsonia, Calyptranthes, Eucalyptus, Foetidia, Sonneratia, Amygdalus, Prunus, Chrysobalanus, Plinia, Banara, Antherylium, and Scolopia.

Digynia.—To this order as yet, only two genera are referred: viz. Crataegus, and Waldsteinia. The former genus is by no means constantly digynous. Even the same species is very inconstant, as to the number of its pistils.

Trigynia.—This order contains only two entire genera, viz. Sorbus and Sesuvium.

Pentagynia.—The genera Tetragonia, Mespilus, Pyrus, Mesembry-

* From εικοσι, twenty, Class of twenty males.

† Professor Martyn.

anthemum, Aizoon, and Spiræa, belong to this order. One species of Spiræa, S. opulifolia, is referred by Willdenow, to the order Trigynia. But this species is by no means constant in the number of its styles.

Polygynia.—The genera Rosa, Rubus, Tormentilla, Dryas, Fragaria, Potentilla, Geum, Comarum, and Calycanthus, belong to this order.

Character.—Athough the class Icosandria cannot be said to be a natural class, in the strict sense of the term, it will not be denied, that it embraces several great assemblages of vegetables, which are related to each other by striking family affinities. The genus Cactus, which stands at the head of the class, does not seem to have much relation with the other genera. This genus, however, together with Tetragonia, Mesembryanthemum, and Aizoon, are referred by L. to his order Succulentæ, formerly mentioned. Cactus gives name to an order *(Cacti)* in the system of Mr. De Jussieu. This order, besides Cactus, embraces the genus Ribes, or Currant, which belongs to Pentandria. Eugenia, Psidium, Myrtus, Calyptranthes, and some others, belong to L's. nineteenth order, *Hesperideæ.** What a pity that L. did not contrive to put his genus Citrus, which, indeed, furnishes us with golden-like fruit, in this poetic order!

Punica, Amygdalus, Prunus, Chrysobalnus, Cratægus, Sorbus, Mespilus, Pyrus, and Spiræa, together with Ribes, are referred to the Swedish naturalist's thirty-sixth natural order, *Pomaceæ.*† All the genera mentioned under the head of the order Polygynia, with the exception of Calycanthus, belong to the thirty-fifth natural order, *Senticosæ.*‡ Alchemilla, Aphanes, and Agrimonia, are also referred to this order. The order *Rosaceæ* in the system of Mr. De Jussieu embraces all the genera of the two Linnæan orders just mentioned, together with several others. The class Icosandria might, with some degree of propriety, be denominated the Esculent class. In the sexual system

* From *Hesperides*, the three daughters of Hesperus, the brother of Atlas whose orchards bore golden fruit, which were kept by a watchful dragon, which Hercules slew, and thus obtained the fruit. The poets have immortalized the name of Hesperides; but, after all the learned labours of the commentators, we are still in the dark as to the situation of these celebrated gardens. Virgil places them in the most western parts of Africa, and adds, that, beside the dragon, the garden contained a priestess and a temple:

> " Hinc mihi Massylæ gentis monstrata sacerdos,
> Hesperidum templi custos, epulasque draconi
> Quæ dabat, et sacros servabat in arbore ramos,
> Spargens humida mella soporiferumque papaver."
>
> Æneid. Lib. iv. 483—485.

I do not doubt, that under the mythological fable of the Hesperides is buried some highly interesting piece of history; perhaps the introduction, after great dangers by sea or land, of some valuable fruits into Greece.

† *Pomaceæ*, from *pomum*, an apple.

‡ *Senticosæ*, from *sentis*, a brier or bramble.

there is no class of the same extent to which we are indebted for such a number of fine esculent vegetables, of the fruit kind. The fruits of some species of Cactus, or Indian-Fig, are deemed good eating. Some species of Eugenia also afford excellent fruits. But the finest and most substantial fruits of this class are those of the genus Amygdalus, comprehending the Peach and Almond; the different kinds of Prunus, known by the names of Plumb and Cherry; of Pyrus, or Apples and Pears; of Mespilus, or Medlars; of Rubus, or Bramble (such as the Rubus idaeus, or Raspberry, the R. caesius, or Dewberry, the R. Chamæmorus, or Cloud-berry,) of Fragaria, or Strawberry, and others. To the materia medica, the class Icosandria has not given many important articles. Some, however, it has given, and these deserve to be mentioned. The genera Eugenia and Myrtus furnish us with those valuable aromatics, the Clove and the Pimento. The shells of the Punica, or Pomegranate, and the root of the Tormentilla, or Tormentil, are still employed as astringent articles, by physicians. The bark of the Prunus virginiana, or American Wild-Cherry, is certainly entitled to the attention of physicians, as a remedy for intermittents, and other diseases.* Different species of Geum, or Avens, have acquired some reputation as substitutes for the Peruvian bark. Buchave has published an express dissertation concerning the virtues of the Geum urbanum, Common Avens, or Herb-Bennet. The American species of Geum are known to be useful medicines, but are generally neglected by physicians. The root of the Spiræa trifoliata, or Indian-Physic, is a good emetic. It is said, that there grows in the State of Kentucky, another species which is still more valuable, as an emetic, than the S. trifoliata. With respect to the remarkable effects of the fruit of the Strawberry in curing the gout of L. how much cause have I to wish, while I write this very paragraph,† that this fine fruit would afford only a portion of similar relief to others afflicted with the same hydra-disease. A large proportion of the Icosandrous genera are natives of the United States. Species of the following genera are, unquestionably, indigenous to this great tract of country: viz. Cactus, Philadelphus, Prunus, Cratægus, Sorbus, Mespilus, Pyrus, Spiræa, Rosa, Rubus, Fragaria, Potentilla, Geum, Comarum, and Calycanthus. It is doubtful whether any part of America possesses a native species of Amygdalus. The Abbe Clavigero expressly informs us, that the Peach (Amygdalus Persica) was imported into Mexico from the old world. I am inclined to think, that this fine vegetable is really a foreigner in *all* the countries of America, in which it is now found. America, I believe, may claim a native species of Pear. But no Apple, properly so called, has been found indigenous in the new world. We can boast, however, of the beauty and perfume of the blossoms of Pyrus coronaria, or Crab-apple. For an illustration of the class Icosandria, see Plate XVIII.

* See Dr. Morris's inaugural Dissertation. Philadelphia: 1802.

† June 11th, 1802.

CLASS XIII.—POLYANDRIA.

The thirteenth class is denominated Polyandria.* This class embraces those hermaphrodite vegetables which are furnished with a number of stamens, that are inserted into the receptacle of the flower. I have already observed, that it is by this circumstance, though it is not expressed in the name of the class, that the Polyandrous vegetables are distinguished from those of the class Icosandria. With respect to the number of the stamens of this class, it is said by L. that they are generally from twenty to a thousand. It is true, that many of the plants of the class Polyandria are furnished with a very great number of stamens, far above twenty; such as Poppy, Capparis, Cistus, Ranunculus, and others. But in the class Icosandria, there are not a few genera which are as abundantly supplied with these sexual organs, such as Cactus, Eugenia, Rosa, and others. By attending however, to the very different manner of insertion of the many-stamened plants of these two classes; we shall have no difficulty in referring them to their proper classes.

Professor Gmelin, in his edition of the *Systema Naturæ*, has united the two classes Icosandria and Polyandria into one, which retains the name of Polyandria! I cannot but consider this as a very injudicious alteration; and I am happy to unite in sentiment, on this subject with a number of able botanists.† The classes Icosandria and Polyandria should be kept apart, and not merely in subordinate divisions, but in the higher associations, or classes. Nature is remarkably regular and constant in the place of insertion of the stamens. Besides, by uniting, or rather *confounding*, the two classes in question, we render the sexual system much more artificial than it really was, when it came from the hands of its Great Architect: we, thus, deprive it of one of its charms, its *occasional* approach to a Natural System. For although the system of L, is professedly artificial, it has, certainly, some claim to the character of a natural assemblage of vegetables; and I cannot help thinking, that in proportion as it is rendered more artificial, it will lose a part of its value.

It has already been observed, that the class Icosandria contains a great number of esculent and innocent vegetables. We shall soon see, on the other hand, that the class Polyandria abounds in poisonous or active vegetables. In this respect, the two assemblages are very different from each other, and this circumstance should have had some weight with rash innovators, before they made the disposition to which I have objected. In fact, the mode of insertion of the stamens in the class Icosandria is a feature of great importance. Even in other classes,

* From Πολυς, many.

† Professsor Martyn, Dr. J. E. Smith, Dr. Darwin, Professor Willdenow, and others.

a like mode of insertion sometimes gives an indication of the wholesome properties of the vegetable. This is the case with the genus Ribes, comprehending the different kinds of Currants, Gooseberries, &c. which are some of the most innocent fruits in the class Pentandria.*

Whilst, however, I object to the melting down of the two classes Icosandria and Polyandria into one class, I confess again that I should have no objection to see the last of these classes, in some measure blended with the class Dodecandria: that is I think it would be well to introduce all the true Dodecandrous plants, having more than ten stamens, into Polyandria. This would, certainly, facilitate the labour of the student. For, after being told, that the Dodecandrous plants have from twelve to nineteen stamens inclusive, with what propriety do we include in the class Polyandria a number of genera in which no botanist perhaps, has ever observed as many as nineteen of the male sexual organs: in which, at least, the number nineteen is exceedingly rare. In Podophyllum, Sanguinaria, and some other genera, we rarely observe more than fifteen or sixteen stamens.†

The class Polyandria is subdivided into seven orders, viz. Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Hexagynia, and Polygynia.

Monogynia.—This first order contains the following genera: viz. Marcgravia, Ternstromia, Alstonia, Trilix, Rheedia, Mammea, Papaver, Cheledonium, Capparis, Actea, Cambogia, Calophyllum, Grias, Sparmannia, Mentzelia, Sloanea, Cistus, Corchorus, Sarracenia, Tilia, Ochna, Muntingia, Elæocarpus, Myristica, Argemone, Lagerstroemia, Thea, Lecythis, Sanguinaria, Jeffersonia,‡ Podophyllum, Bixa, Nymphæa, Trewia, Laetia, Seguieria, and Delima.

Digynia.—This order is much less extensive than the first. It contains the following genera, viz. Calligonum, (which is referred by Willdenow to the class Dodecandria,) Fothergilla, Curatella, and Pæonia.

Trigynia.—The genera Delphinium and Aconitum are referred to this order; as is also a species of Reseda, Reseda Luteola, called Yellow-weed, or Dyers-weed.

* The stamens of the Ribes are inserted into the calyx.

† In some of the earlier editions of the *Genera Plantarum*, several genera which were afterwards introduced into Dodecandria, had actually a place in Polyandria. I here mention the names of these genera, viz. Bocconia, Cratæva, Euphorbia, Peganum, Portulaca, Triumfetta, Heliocarpus, and Reseda. See Genera Plantarum, &c. Editio secunda. Lugduni Batavorum: 1742.

‡ Jeffersonia has, very generally, only eight stamens. Sometimes however, it has more; but never, I believe as many as twenty. From its near affinity to Podophyllum, and Sanguinaria, it may with as much propriety be introduced into the class Polyandria, as these two genera.

Tetragynia.—This order contains the genera Tetracera, Caryocar, and Cimicifuga.

Pentagynia.—Aquilegia, Nigella, Reaumuria, and Brathys belong to this order.

Hexagynia.—The genus Stratiotes, or Water-Soldier, and Brasenia belong to this order.

Polygynia.—This beautiful order contains the following genera, viz. Dillenia, Illicium, Liriodendron, Magnolia, Michelia, Uvaria, Annona, Nelumbium, Anemone, Atragene, Clematis, Thalictrum, Adonis, Ranunculus, Trollius, Isopyrum, Helleborus, Caltha, Houttuynia, Hydrastis, Drymis, and Unona. Also a new and singular North American genus, of which two species are now known. They are aquatic plants, with peltate leaves.

Character.—By some writers the class Polyandria has been deemed a natural class. As such I cannot consider it, though it is unquestionably, more natural than some of the other classes of the sexual method. It is one of those classes which comprehend several pretty natural families of vegetables, that are related to each other by affinities more or less striking. I shall here mention the principal natural assemblages of this class.

The genus Capparis belongs to L's. twenty-fifth natural order, *Putamineæ.** This plant gives name to an order in the system of Mr. De Jussieu, the order *Capparides:* the fourth order of his thirteenth class. It embraces, beside Capparis the genus Marcgravia, together with Crataeva, Reseda, Drosera, and Parnassia, of preceding classes, not to mention others. Bixa, Tilia, and Thea form a part of L's. order *Columniferæ.* Cistus belong to his twentieth order, *Rotaceæ.*† This genus gives name to the twentieth order of Jussieu's thirteenth class: the order *Cisti,* which does not appear to me to be a natural assemblage of vegetables. The genera Papaver, Chelidonium, Glaucium, Argemone, Sanguinaria and Podophyllum, together with Bocconia (of the XIth class) belong to L's twenty-seventh natural order, *Rhoeadeæ*‡. Papaver gives name to an order in the System of Mr. De Jussieu: the order *Papaveraceæ,* which embraces beside Papaver, all the genera of L's. Rhoeadeæ (Podophyllum excepted,) and some others. The following Polyandrous genera belong to L's. twenty-sixth natural order, *Multisiliquæ*§: Actæa, Pæonia, Delphinium, Aconitum,

* *Putamineæ,* from *putamen,* a shell because the fleshy seed-vessel or fruit, of these plants is frequently covered with a hard and woody shell.

† *Rotaceæ,* from *rota,* a whell; because several of the plants of this order have a flat wheel-shaped petal (*corolla rotata,*) without a tube.

‡ *Rhoeadeæ,* from *Rhoeas,* the name of Dioscorides and Pliny for the common Corn-Poppy.

§ *Multisiliquæ,* from *multus,* many, and *siliqua,* a pod because the plants of this order have more seed-vessels than one. The name, however, of this order is by no means an appropriate one; for the plants do not bear pods (*siliquæ,*) but in general, many dry capsules: some of them are furnished with no proper seed-vessel, but have numerous distinct seeds.

Cimicifuga, Aquilegia, Nigella, Atragene, Clematis, Thalictrum, Isopyrum, Helleborus, Caltha, Anemone, Trollius, Ranunculus, and Adonis, &c. together with Myosurus, Dictamnus, Ruta, and Peganum of preceding classes. The whole of the genera of this order with the exception of the three last-mentioned genera, belong to Jussieu's order *Ranunculaceæ,* which also embraces Podophyllum, and Zanthorhiza. Liriodendron, Magnolia, Michelia, Uvaria, and Annona, are the principal genera, in L's. fifty-second natural order, called *Coadunatæ.** In the system of Mr. De Jussieu, the order *Magnoliæ (les Magnoliers)* embraces, beside Magnolia, the following genera: viz: Liriodendron, Dillenia, Illicium, Michelia, and Talauma. Anona, Unona, Uvaria, and others, belong to Jussieu's order, *Anonæ.* The class Polyandria contains a great number of poisonous vegetables, and this, as I have already said, is one of the reasons why the class ought not to have been confounded with Icosandria, which abounds in esculents. L. has observed, that there is not one esculent vegetable in the great order Multisiliquæ, and that most, if not all, the plants of this order, are poisonous, though not one of them is lactescent.† I believe the whole of what is here said, is nearly true. I know not more than one or two esculent vegetables in the order. Nigella arvensis is, indeed, cultivated for its seed, which have an agreeable aromatic taste and smell; the young flower-buds of Caltha palustris, or Marsh-marigold, are, in some countries, pickled and sold for capers. But these two plants can hardly be said to furnish exceptions to the Swedish naturalist's observation. Ranunculus Ficaria, or Pilewort Crow-foot, it must, however, be observed, is eaten in some countries, both as a sallad, and when boiled. By boiling, even the acrid tuberous roots of Ranunculus bulbosus, are rendered so mild that they are eaten in Scotland. It is probable, that by the same treatment, not a few other acrid Polyandrous plants might be rendered esculent and innocent.

It must not, therefore, be supposed, that in the class Polyandria there are no innocent vegetables. On the contrary, there is a considerable number of such. The ripe fruit of Podophyllum peltatum is good eating, and is greatly esteemed by many persons. The wild-pigeons (Columba migratoria) are said to feed upon this fruit. Different species of Annona also furnish an innocent and wholesome fruit. The fruit of the Annona triloba called in the United States, Papaw, and Custard-apple, is extremely luscious, and when perfectly ripe is, I believe, entirely innocent. The ripe seeds, or nuts, of the American Nelum-

* *Coadunatæ*, from *coadunare*, to join or gather together. This order seems to take its name from the general appearance of the seed-vessels, which are numerous and being slightly attached below, form together a single fruit, in the shape of a sphere, or cone.

† Speaking of this order, L. says, "Odor fœtidus, etiam in Omnibus fere, adeoque nulla hic esculenta, & pleræque, si non omnes, venenatæ, quamvis nulla harum lactescat." Prælectiones, &c. p. 383.

bium (Nymphæa Nelumbo? of L.) are greatly esteemed by the Indian and white inhabitants of the United States. The different species of Tilia, or Lime-tree, are innocent; and Magnolia, Liriodendron, with some other genera, in this class, are not more active or deleterious than are many of the genera in the class Icosandria.

In a medical point of view, the class Polyandria is one of the most important in the sexual system. This importance, however, is not so much owing to the number of medicinal articles which this class embraces, as to the value of a few of those articles. The most important article of the class, and one of the most indispensible in the hands of physicians, is Opium, the produce of a species of Papaver, or Poppy: the Papaver somniferum. This vegetable might be cultivated in the United States, with much *pecuniary* profit. The Gamboge of the shops is the produce of at least three different vegetables, one of which is the Cambogia Gutta of the class under consideration. This plant is a native of India.* The Ladanum of the shops is the produce of a species of Cistus. Tea may, with some propriety, be mentioned as a medicine. As a medicine I believe it possesses no mean virtues; and such are its powers, that it is capable of doing much injury.† *Expertus loquor*. The root of the Sanguinaria canadensis, called in the United States, Indian-Paint, Puccoon, Turmeric, &c. is said to be endued with useful medical powers. The root of the Podophyllum peltatum, or May-apple, is an excellent purgative. I believe the root of Jeffersonia binata possesses similar powers.

Delphinium, Aconitum, and Cimicifuga are active plants. The Aconitum Napellus, or Monks-hood, has been highly praised by Dr. Storck, of Vienna, as a remedy for various diseases. All Storck's medicines seem entitled to some attention. That pernicious vegetable the "Stagger-weed," so destructive to the horses in some parts of the United States, is either an Aconitum or a Delphinium. The root of Hydrastis canadensis, called Yellow-root, furnishes a beautiful yellow-dye, and is said to be useful as a tonic in dyspeptic, and other affections. Some attention has been paid to different species of Clematis,‡ but the plants of this genus are worthy of much more attention, than has been bestowed upon them. The leaves of Clematis crispa and Clematis Viorna are very acrid, and might I doubt not, be employed with advantage, in some diseases, such as chronic rheumatism, palsy, old ulcers, &c. These vegetables are the favorite food of one of the most active species of American blistering flies, the Lytta marginata of Fabricius. Does this insect derive any portion of its active property from the vegetables upon which it feeds? The medical properties of the

* Gamboge is procured from a species of Hypericum, the Hypericum bacciferum, and from the Stalagmitis Cambogioides.

† See Dr. Lettsom's splendid and very interesting work, The natural History of the Tea-Tree, &c. &c. London: 1799. 4to.

‡ Particularly Clematis recta.

various species of Thalictrum, or Meadow-Rue, have been but little attended to. The root of Thalictrum flavum has been used as a purgative, aperient, tonic, &c. In some parts of the United States, one of the indigenous species of this genus has acquired the character of a specific against the bites of venomous serpents. Most of the species of Ranunculus are plants of considerable acrimony. Ranunculus acris, R. sceleratus, R. Flammula, R. bulbosus and R. Ficaria (the last of which is the mildest species of the genus) have all excited the attention of physicians, as remedies for different diseases. Some species of Anemone are also plants of considerable acrimony. The properties of Anemone nemorosa, A. pratensis, and A. Hepatica have solicited the attention of physicians. Anemone pratensis, or Meadow-Anemone, is one of the active vegetables which were the subjects of Baron Storck's inquiries.—Different species of Hellebore have long maintained a place in the materia medica. The root of the Helleborus niger is an active purgative. It has been doubted whether the Hellebore of Hippocrates was this or any other species of the genus. Some writers have supposed, that the Greek physician made use of a species of Adonis. The Helleborus foetidus, or Stinking Hellebore, has acquired much reputation, both in Europe and in the United States, as a remedy against worms.* Helleborus trifolius is one of the vegetables that are common to North America and Asia. The root of this species is used, in some parts of the United States, as a remedy for sore-throat. As one of the *plantæ tinctoriæ*, or dies, it is well worthy of attention. The medical properties of the Liriodendron Tulipifera, or Tulip-tree,† and the Magnolia glauca, or Common Magnolia,‡ have been the subjects of late investigation. These two fine vegetables are, certainly, worthy of the notice of physicians. Other species of Magnolia should be examined. A considerable number of the genera belonging to the class Polyandria are natives of the United States. This tract of country is especially rich in vegetables of the following genera: viz. Sarracenia, Nymphæa, Magnolia, Annona, Anemone, Clematis, Thalictrum, Ranunculus. The whole genus of Sarracenia, so far as is yet known, is exclusively confined to America. For an illustration of the class Polyandria, see Plate XVIII.

CLASS XIV.—DIDYNAMIA.

Didynamia§ is the name of the fourteenth class. This class, as well as the fourth class, contains those hermaphrodite flowers which are furnished with four stamens, or male organs. But in the class Tetran-

* See my Collections for an Essay, &c. &c. page 38.
† See Dr. Roger's Inaugural Dissertation. Philadelphia: 1802.
‡ See Dr. Price's Inaugural Dissertation. Philadelphia: 1802.
§ Didynamia, from δις, twice, and δυναμις, power.

dria, as we have already observed, the stamens are all of one uniform length; or, at least, there is no regular inequality between them. In the plants of the class Didynamia of which I am now treating, two of the stamens are constantly long, and two short. The stamens are disposed in pairs, the outer pair being longer, the middle pair shorter, and converging. In all the preceding thirteen classes of the sexual system, the orders are founded upon the number of the styles, or female organs. To this circumstance, however L. has paid no attention in constructing the orders of Didynamia, or, indeed, of any of the succeeding ten classes. The orders of Didynamia are two in number, viz. Gymnospermia and Angiospermia.

Gymnospermia.—The order Gymnospermia* contains these Didynamous plants, which are destitute of a proper pericarp, or seed-vessel, but have their seeds naked. In Prasium, however, the seed are enveloped in a succulent epidermis, which may, with propriety, be considered as the pericarp of this plant. Another essential character belongs to the plants of this order: they have four seed. In Phryma, however, there is but one seed. The following genera belong to this order, viz. Perilla, Leonurus, Glechoma, Hyssopus, Mentha, Sideritis, Lavandula, Teucrium, Ajuga, Phlomis, Betonica, Lamium, Galeobdolon, Stachys, Nepeta, Satureja, Ballota, Marrubium, Moluccella, Scutellaria, Thymus, Ocymum, Prunella, Cleonia, Trichostema, Dracocephalum, Origanum, Clinopodium, Thymbra, Melittis, Melissa, Horminum, Prasium, and Phryma.

Angiospermia.—The order Angiospermia† contains those plants answering to the classical character, which have their seed covered, that is lodged in a proper pericarp, or seed-vessel. This is a constant character, and very naturally distinguishes the plants of this order from those of the preceding division. This second order, which is more extensive than the first, contains the following among other, genera, viz. Castilleja, Obolaria, Orobanche, Hebenstretia, Torenia, Acanthus, Premna, Cressentia, Halleria, Selago, Lippia, Lathræa, Bartsia, Euphrasia, Rhinanthus, Melampyrum, Schwalbea, Barleria, Loeselia, Gmelina, Lantana, Avicennia, Tozzia, Limosella, Browallia, Lindernia; Vandellia, Gesneria, Scrophularia, Stemodia, Celsia, Sibthorpia, Capraria, Digitalis, Bignonia, Ruellia, Buchnera, Erinus, Petræa, Manulea, Antirrhinum, Columnea, Gerardia, Pedicularis, Mimulus,

* Gymnospermia, γυμνος, naked, and σπερμα, seed *Gymnotetraspermæ* (a term derived from the Greek words γυμνος, τεσσαρες, four, and σπερμα, a seed) is the name of a division in the methods of Hermann and Boerhaave. This division comprehends those plants which have four naked seed, as in Borago, Symphytum, and other Asperifoliæ, formerly mentioned; and also the plants which flower at the joints, such as Mentha, Origanum, and other verticillate plants, now under consideration, (order of naked seeds.)

† Angiospermia, from αγγος, a vessel, and σπερμα, a seed. Seed in a covered capsule.

Dodartia, Chelone, Sesamum, Penstemon, Martynia, Craniolaria, Pedalium, Amasonia, Linnæa, Bontia, Cornutia, Clerodendron, Volkameria, Citharexylon, Ovieda, Millingtonia, Vitex, Duranta, Besleria, Hyobanche, Cymbaria, Thunbergia, and Melianthus.

Character.--L. has asserted, that the class Didynamia is a very natural class, and that it contains no genus which does not in strict propriety, appeartain to it.* He places the essential character of the class in the circumstance of the plants having four stamens, two of which are long and two short; in the anthers converging, or inclining towards each other; in their being but one style, or female organ, and in the corolla being of an irregular shape. L. has not wanted followers, even where he has been most propense to paradox. Other writers have considered the class under consideration as a natural class. Professor Van Royen, in his *Floræ Leidensis Prodromus*, published in 1740, has endeavored to dispose of the plants enumerated and described in that work, under a number of natural families, or orders. His method is, unquestionably more natural than the sexual method of the Swede; indeed, several of the orders may be considered as very natural assemblages. In this work, the plants of the class Didynamia of L. are thrown into one entire family or order, which is designated by the name *Ringentes*, or the Grinning-Flowers. I cannot consider the class under consideration as a natural class, though it is, indeed, much more natural than several of the other classes of the sexual system. For an enumeration of the various characters, or features, which show an affinity of the plants of this class to one another, I must refer the reader to the *Genera Plantarum* of L. But though I cannot admit, that this class, taken in the aggregate is a natural one, it must be admitted, that the two orders into which it is subdivided, may with great propriety, be considered as two vast natural families, or assemblages, each characterized by a set of features which almost exclusively belong to it. In other words, the two orders are very dissimilar from each other: so dissimilar that "it would have been difficult (to use the words of Dr. Milne,) except from the number and proportion of the stamina, to have reduced them under one head, with any degree of certainty and decency. The petals, seed-bud, seed-vessel and seed, are totally different in the two orders. The habit too, or general appearance of the plants, is perfectly different."†

L. himself, notwithstanding what he has said in the *Genera Plantarum*, appears to have been fully sensible of the few family affinities

* "Classis hæc est Naturalissima, nec ullum genus ab eo excludi potest." *Genera Plantarum*, &c. In some of the early editions of this work, the genus Cunila, and some others, which were afterwards transferred to the class Diandria, were placed in Didynamia. There is, indeed a very great affinity between the Diandrous plants with ringent flowers: and the plants of the first order of Didynamia. It is a pity, that the principles of the sexual system did not permit its illustrious author to associate these plants more nearly together, or under the same class.

† A Botanical Dictionary, &c. article Didynamia.

that subsist between the two orders of the class in question. Accordingly, in his work on the *natural orders*, he has disposed of the greater number of the plants of the class Didynamia under two great natural families, which he calls *Verticillatæ* and *Personatæ.*—These are his forty-second and his fortieth orders.

The term Verticillatæ* was used by Ray, from whom L. borrowed it. It comprehends, besides the plants of the order Gymnospermia, several Diandrous plants, such as Lycopus, Amethystea, Ziziphora, Monarda, Rosmarinus, Salvia, Cunila, &c. The term Verticillatæ is synonymous to the *Labiati*, or Lip-flowers, of Tournefort, so called from the unequal and irregular divisions of the petal, or corolla, which is imagined (and in some species actually does) to resemble the lips of an animal. In the system of Mr. De Jussieu, these plants form an order (the sixth of his eighth class) by the name of *Labiatæ.*

At the properties of the verticillate plants I have already hinted, in a former part of this work. I may now add, that most of these plants contain a very fragrant, odorous matter, that they are of a warm and penetrating nature, and that few, if any, of them are poisonous. These plants were formerly much more employed in medical practice, than they are at present. By the old physicians, and by many of the moderns, in some parts of the world, they were deemed cephalic, or imagined to be peculiarly adapted to the diseases of the head. There does not appear to be any good foundation for this notion, which seems to have originated in days of a less correct science than the present. Perhaps, however, some of the verticillate plants are too much neglected in the modern practice of physicians. It is not likely, that they will soon lose their reputation, which they have long maintained, as domestic medicines. Many of these plants delight to grow in dry situations, which are frequently among the healthiest in every country: in situations, I think, peculiarly exempted from the various forms of intermittent fevers.

The order Personatæ contains many of the plants of the second division, or Angiospermia. They are furnished with that particular species of corolla, which we have called *corolla personata*, personate or masked corolla. This is said to resemble the head or snout of an animal. Most of the plants of this natural order are referred by Mr. De Jussieu to his order *Scrophulariæ.* This is the seventh order of his eighth class. The genus Digitalis, however, which the French botanist includes among the Scrophulariæ, is referred by L. to his order Luridæ formerly mentioned. It has been justly observed, that there is a great affinity between the plants of the order Angiospermia, and many of the plants of the first order of the class Pentandria. Several species of the genera belonging to the second division of Didynamia, are constantly furnished with five stamens,† and many others, beside

* *Vertilicillatæ*, from *verticillus*, a whirl, or whorl.

† Bignonia sempervirens (a North American plant) has five complete stamens

the four stamens, characterising the class, have the rudiment of a fifth stamen.* The agreement between the two classes does not end here. Several of the covered-seeded plants of Didynamia are poisonous, and we have already seen, that there are a great number of deleterious plants in the first order of Pentandria. I think we are much less acquainted with the medical properties of the plants of the second than with those of the first order of Didynamia. Much attention, however, has been paid to the powers of a few of the Angiospermous plants. Every physician now acknowledges the highly valuable powers of the Digytalis purpurea, or Purple Foxglove: one of the most inestimable articles in the Materia Medica. Useful qualities have been ascribed to different species of Antirrhinum, or Snapdragon, and Scrophularia, or Figwort not to notice several others. Gerardia flava (one of the most common North American plants) is said to have been used with advantage, in obstinate intermittents. Euphrasia will, in all probability, live much longer in the lines of Milton than in the lists of future writers on the materia medica. A species of Orobanche (the Orobanche virginica,) called in the United States Cancer-root, has acquired some reputation as a remedy for cancerous affections. The sensible qualities of the plant lead me to suspect, that it is endued with useful medical powers. The Orobanche major, or Greater-Broom-rape, a native of Europe, is a very astringent plant, and is† said to have been found useful, externally applied, in cases of ulcers. It deserves to be mentioned, that many of the plants of Angiospermia turn black by drying, and hence it is difficult to preserve the beauties of these plants in our *Horti Sicci*, or *Herbaria.* Bartsia, Melampyrum, Rhinanthus, Buchnera americana, and some species of Gerardia, are among the number of these plants. The plants of other classes likewise turn black when drying. This is the case with Podalyria and Monotropa, in the class Decandria. *Apotheosis of Botanists.* The second order of the class Didynamia embraces a great number of genera which are named in honour of distinguished botanists and naturalists, or cultivators of these sciences. The name of L. is affixed to a little plant of this order, which is a native of three portions of the earth; of the northern parts of Europe, of Asia, and of North America. May the species be preserved to perpetuate the beloved name of that illustrious man.—But the name of L. together with the memory of his services, will, in all probability, survive many of the species of vegetables which are, at present extensively diffused over the surface of the earth. The order under consideration has consecrated the names of other illustrious men; of Haller (worthy to be the rival of L.) of Conrad Genser, one of the fathers of natural history; of Fabius Columna, of Gerard, of Professor Martyn (the able commentator on the *Georgics* of Virgil,) of Thunberg, and a brilliant constellation composed of many others, some of whom are still living. The practice

* Such are Tanaccium, Chelone, Sesamum, Martynia, &c.
† By Floyer, &c.

of giving personal names to plants is of an high antiquity. Perhaps, it is nearly as ancient as the first study of plants. It is a practice which I hope will never fall into neglect, though I am sensible it has often been abused. A late ingenious writer* has observed, that "it may be styled the *apotheosis* of botanists; and L. may be compared to the high priest who has thus immortalized a numerous group of celebrated men. The following are some of the Didynamous genera that are found native within the limits of the United States, viz. Mentha, Westringia, Stachys, Nepeta, Scutellaria, Prunella, Trichostema, Dracocephalum, Clinopodium, Phryma, Obolaria, Orobanche, Bartsia, Melampyum, Lindernia, Scrophularia, Bignonia, Ruellia, Buchnera, Antirrhinum, Gerardia, Pedicularis, Mimulus, Chelone, Penstemon, Martynia, and Linnæa.

For illustrations of the class Didynamia, see Plates IV. and XIX.

CLASS XV.—TETRADYNAMIA.

Tetradynamia† is the name of the fifteenth class, this class as has been already observed, embraces those hermaphrodite flowers which have six stamens, four of which are long and two short. By this character, we readily distinguish the plants of the class Tetradynamia from those of the class Hexandria. We shall presently see, how essentially the subjects of these two divisions of the sexual method differ from each other; in regard, at least, to their aspect, or physiognomy. Between the properties of these plants, there is a much greater affinity than seems to have been suspected. This class is divided into two orders, viz. Siliculosa and Siliquosa. These orders are founded upon the circumstance of the form or shape of the pericarp, or seed-vessel. This it has already been observed, is a species of pod, in which the seed are alternately affixed to either suture, or joining of the valves.

Siliculosa.—The plants of this order are furnished with that particular species of pericarp, which we have called *silicula*; silicle, or little pod, or pouch. The following are the principal genera which belong to this order, viz. Draba, Lunaria, Subularia, Myagrum, Vella, Isatis, Crambe, Bunias,‡ Iberis, Alyssum, Clypeola, Peltaria, Cochlearia, Coronopus, Lepidium, Thlaspi, Biscutella, and Anastatica.

Siliquosa.—The plants of the second order are furnished with that

* Dr. Pulteney. See his very entertaining work entitled, Historical and Biographical Sketches of the Progress of Botany in England, &c. Vol. II. p. 47.

† Tetradynamia, from τεσσαρες, four, and δυναμις, power.

‡ L. has placed the three genera Isatis, Bunias, and Crambe in the second order of the class, but I think it more proper to place them in the first order, as has been done by Dr. Smith (*Flora Britanica*, &c.) and some other writers; for each of these genera is, unquestionably, furnished with a true *silicula*, or silicle.

species of pericarp, which we have called *siliqua* or silique. It may here, again, be observed, that the silicle and the silique, do not essentially differ from each other: they differ only in form and size. The latter is much longer than broad; as in Mustard: the former is almost round or makes a nearer approach to the orbicular figure; as in Honesty (Lunaria;) and Shepherds-Purse, or Thlaspi.

This order contains the following genera, viz. Raphanus, Erysimum, Cheiranthus, Hesperis, Arabis, Brassica, Turritis, Dentaria, Ricotia, Cleome, Cardamine, Sinapis, Sisymbrium, and Heliophila.

Character.—The class Tetradynamia is, unquestionably, the most natural class in the sexual method. If we except the genus Cleome* (Bastard-Mustard,) which is a very irregular family of plants, allied both to the Polyandrous and Gynandrous plants, the whole class does not contain a single genus which ought agreeably to the laws of any *natural* system, to be excluded from it. All botanists as L. himself has observed, have perceived the affinity which subsists between the plants of this class.† Morison, Hermann, Ray, and Boerhaave had, long prior to the publication of any of L.'s writing, denominated these plants *Siliquosæ*, and *Siliculosæ*. Tournefort has denominated them *Cruciformes;* Haller, *Cruciatæ*, and Jussieu, *Cruciferæ*. Tournefort and Haller have disposed of these plants under two general heads, viz. *Siliculosæ* and *Siliquosæ*, founding their divisions upon the form of the pod, as L. himself has done in his sexual method. The terms Cruciformes, Cruciatæ, &c. were imposed upon these plants, from the form of the corolla, which has already been noticed. In his work on the natural orders, L. has thrown all the genera of the class Tetradynamia (Cleome excepted‡) into one great division, by the name of *Siliquosæ*. These constitute his thirty-ninth order.

The following characters belong, in general, to these plants. Hitherto, there has not been discovered a single instance of a true tree in the whole order. Some, species, however, are shrubby. The root is fibrous, fusiform, or tuberous. None of them are furnished with a bulb, in the L. sense of the word: yet to an American species of Arabis, the specific name of *bulbosa* has been affixed. The caulis, or stem, is generally herbaceous. The leaves are alternate. They have neither stipules, tendrils, or prickles. In most species, the flowers are disposed in a corymb, which is gradually elongated into a raceme; so that while the flowers are corymbous, the fruit is racemous. The calyx is tetraphyllus, or four-leaved, and in most species deciduous. The petals are four, and unguiculate, or clawed: but some species have flat petals. Some are destitute of petals. In general, they have glands upon the receptacle. The stamens, as has already been observed, are six in number, four long and two short. The two opposite ones are shorter, or, at least, more spreading. (Some species of Lepidium, however, are strictly Hex-

* See the explanation of Plate XXVI.

† Prælectiones, &c. p. 481.

‡ Putamimineæ, L.

androus; that is, there is no regular inequality in respect to the length of the stamens. Cardamine hirsuta has frequently no more than four stamens, the two shorter ones being deficient. In Cleome, the number of the stamens is various.) The fruit is a silicle, or silique: two valved, and two-celled, and containing many seed. In Isatis and Crambe, the fruit contains but a single seed. The general properties of the Siliquose plants are well known to us. They have an acrid, lixivial taste. This, in some species, is very powerful; as in the Cochlearia Armoracia, or Horse-radish, and the Sinapis, or Mustard. In other species, the acrimony is very inconsiderable, as in Brassica Rapa, or Turnip, and other species of the genus. I believe, however, that all these plants are considerably acrid whilst growing in their wild state, or in particular soils. Thus the Horsė-radish is much more acrid in wet situations than it is in our gardens. Even the Turnip, when it is restricted to wet ground contracts a remakable acrimony. Cultivation has rendered these plants much milder, and more agreeable to our palates. It would seem, indeed, that the properties of the Tetradynamous plants are remarkably influenced (more, I think, than the properties of most other plants, the Umbelliferæ perhaps excepted) by the soil and climate in which they grow. The active powers of these plants reside more especially in the roots and seeds. If these be made into cataplasms, and applied to the surface of the body, they excite a considerable degree of heat, redness and inflammation. Hence, they are denominated "rubefacients, and topical stimulants." If the application be continued for a longer time, they often induce, as cantharides, and other similar insects do, a vesication, or discharge of serous fluid from the part. Their operation extends much further. They increase the force and frequency of the circulation, and the heat of the body. Taken into the stomach, they excite vomiting and purging, and promote the discharge by the kidneys. They sometimes produce a considerable *ardor urinæ;* and, like cantharides, turpentine, and other articles, they induce *stranguria.* They sometimes increase the secretion from the surface of the body. I have known them to induce considerable and very troublesome headache. There are reasons to believe, that the peculiar acrimony of these plants is conveyed, but little altered by the powers of the system, into the course of the circulation. Very few, if any, of the plants of this class are poisonous. It must not be denied, however, that to some of the Tetradynamous plants have been ascribed effects which, if actually induced by these plants, would lead us to believe, that they are really poisonous. The seed of the Raphanus Raphanistrum, or White-Charlock, a native of various parts of Europe, are sometimes mixed with grain, and made into bread. This bread is said to have frequently produced, in different parts of Europe a dreadful disease, to which L. and Cullen have given the name of *Raphania.** This is defined by the last mentioned nosolo-

* It is the convulsio raphania of Sauvages.

gist, "a spasmodic contraction of the joints, with convulsive agitation, and most violent, periodical pain." In the *Amoenitates Academicæ,** there is a very ample account of this singular disease, which is confidently ascribed to the White-Charlock. It may, however, be doubted, whether the disease has any necessary connection with the use of this vegetable. This must be decided by future inquiry and more extended information. I cannot, in this place, state the grounds of my doubt. But I can, with much satisfaction, refer my reader to the dissertation which I have mentioned. It is proper, in this place, to observe, that the analysis of the Tetradynamous plants furnishes the chemist with some peculiar products, which are not at all, or less abundantly, obtained from other plants. Submitted to distillation, they give out a large quantity of volatile-alkali, or ammoniac. It is generally supposed that this alkali is formed during the operation of distillation, by the union of the nitrogene, or azotic gas, and the hydrogene, or inflammable air.

Mr. Deyeux has shown, that sulphur naturally exists in some of those plants, as in Cochlearia. There are good reasons to suppose, that a great deal of the sulphur which is so abundantly diffused through the earth, has been formed by the decomposition of vegetables. The seeds of Mustard, Rocket, Garden-cresses, and other plants of the class, afforded the celebrated Margraaf, a fine phosphorus. Berthollet finds the phosphoric acid principally in those vegetables which yield ammoniac, by distillation. I believe, however, it is certain, that a considerable number of plants which yield the phosphoric acid, do not yield ammoniac. The acid in question has been discovered† in some of the Didynamous plants lately mentioned; as in Antirrhinum Linaria (Ransted-weed.) The researches of the chemist have shown, that this acid is much more extensively diffused through the vegetable world, than was formerly supposed. Meyer thinks he can detect it in the green resinous parts of the leaves of vegetables.

The class Tetradynamia is, upon the whole a very important class. It furnishes us with several alimentary articles, which are extremely nutritious, such as the Turnip, the different varieties of Cabbage, &c. It likewise furnishes us with several of those stimulating articles such as Mustard, Horse-radish, &c. to which we have given the name of *condiments*. To the materia medica, properly so called, this class has not given many very indispensible articles. Some, however, it has given, and these, I think, are more important than they are generally deemed. The principle of these are Mustard (Sinapis nigra, &c.,) and Horse-radish. These are especially valuable, when externally applied, in the shape of cataplasms. Thus employed, they are, in the treatment of some diseases, among the most valuable implements in the hands of physicians. They are also found very useful, when exhibited internal-

* Vol. VI. Dissertatio CXXIII.

† By Mr. Hessenfratz.

ly, in the management of dropsy, scurvy, gout, palsy, and other diseases. The flowers or Cardamine pratensis (Meadow-Ladies-smock, and Cuckow-flower) have been recommended, by Sir George Baker, and some other physicians, as a remedy for spasmodic asthma, chorea, and other similar diseases. A species of Cleome is employed in some parts of the United States, as a remedy in cases of worms.* The powerfully-fetid smell of some species of this genus, renders it probable, that they may be useful medicines, not only in cases of worms, but also in other diseases. The seed of Sisymbium Sophia (Flix-weed) have likewise been employed as an anthelmintic; and are said by Mr. Durande, to be a powerful remedy in restraining uterine hæmorrhages.

The following Tetradynamous genera are natives of the United States, viz. Draba, Thlaspi, Cochlearia, Arabis, Brassica, Dentaria, Cleome, Cardamine; Sinapis, and Sisymbrium. Our country cannot be said to abound in the plants of this class. It must be mentioned, however, that several new species of the genera which I have enumerated have, within a few years been discovered in the United States.—Peter Osbeck, one of the pupils of L. informs us, that he did not find one Tetradynamous plant growing "spontaneously" in China. Some species of Brassica, however, are known to be natives of this vast empire. I have introduced the observation of Osbeck in this place, because it is a fact that the *Flora* of China and that of North America, in the same latitudes, are extremely similar to each other. For an illustration of the class Tetradynamia, see Plate XIX. Fig. 3.

CLASS XVI.—MONADELPHIA.

To the sixteenth class of his system, L. has given the name of Monadelphia.† By the English botanists, this is called the class of One Brotherhood,‡ and the class of Threads United.§ This vast and interesting class embraces those hermaphrodite vegetables, which have all their stamens, or male organs, united below, that is by their filaments, into one body, or cylinder, through which the pistil, or female organ, passes. Other classical characters of these plants will be particularly detailed afterwards. The orders of the class Monadelphia are nine in number, and are founded upon the circumstance of the number of stamens. The names of these orders, with the exception of the seventh, are the same as those of several of the preceding classes. The circumstance is well calculated to show, how unwilling L. was to neglect the sexual organs, in the formation of his system. Perhaps it would not have been difficult to have discovered a better foundation upon which to have constructed the ordinal divisions of the class in question.

* See my Collections for an Essay &c. p. 64.

† Monadelphia, from μονος. one or alone, and αδελφια, a brotherhood.

‡ Darwin.

§ Withering.

The names of the orders Monadelphia are Triandria, Pentandria, Heptandria, Octandria, Eenneandria, Decandria, Endecandria, Dodecandria, and Polyandria.

Triandria.—The first order contains the two genera, Aphyteia and Galaxia.

Pentandria.—Lerchea, Waltheria, Hermannia, Melochia, Symphonia, and Erodium belong to this order.

Heptandria.—To this order belongs the genus Pelargonium, "an excellent genus," which includes most of the Geraniums that are natives of the Cape of Good-Hope: a portion of the world which is immensely rich in the genera and species of plants, many of which have not been discovered in any other parts of the earth.

Octandria.—To this order is referred the genus Aitonia, which appears to have but little family affinity to the other plants of the class.

Enneandria.—The genus Dryandra belongs to this order.

Decandria.—This order contains the genera Connarus, Hugonia, and Geranium. This last-mentioned genus was confounded by L. and other botanists, with the two genera Erodium and Pelargonium, which have been already mentioned. We are indebted to the late Mr. L'Heritier (one of the most able of the modern botanists) for the better arrangement of these plants. He has divided the Linnæan genus of Geranium into three distinct families, viz. 1. Erodium (comprehending Geranium romanum, G. cicutarium, G. moschatum, &c. of L.,) which has five fertile stamens: 2. Pelargonium (comprehending Geranium pinnatum, G. lobatum, G. odoratissimum, and many others,) the species of which have, in general, seven fertile stamens; and 3. Geranium, properly so called, the species of which have, most commonly, ten fertile stamens. Some species of the genus Oxalis, which L. has referred to his tenth class, are strictly monadelphous in their structure, and, as having ten complete stamens, are referred to the order Decandria of the present class. The genera Spartium, Genista, Anthyllis, Ulex, and Ononis, also belong to this order of Monadelphia, though they are arranged by L. in his class Diadelphia.

Endecandria.*—To this order is referred the genus Brownea, the proper number of whose stamens is, I believe, somewhat doubtful. The species of this genus are, however, sometimes found with ten stamens.

Dodecandria.—This order contains the genus Pentapetes.

Polyandria.—This is the most extensive and Magnificent order of the clsss. The following are the principal genera which it contains, viz. Gustavia, Gordonia, Morisonia, Mesua, Stewartia, Napæa, Sida, Anoda, Laguna, Palava, Solandra, Bombax, Adansonia, Barringtonia, Carolinea, Gossypium, Lavatera, Malacra, Fugosia, Pavonia, Malva, Malope, Urena, Alcea, Hibiscus, Malvaviscus, Althæa, Camellia, and several others, particularly genera of the Abbe Cavanilles.

* Endecandria, from ενδεκα, eleven.

Character.—"Classis hæc naturalissima est, nec ullum genus ex datis est, quod addi vel demi, potest." These are the words of L.* The class Monadelphia is indeed, upon the whole: a natural class. The proof of this assertion may, I apprehend, be deduced, with some degree of confidence, from the single circumstance, that almost all botanists, in pursuit of a natural method, have associated under one head, the greater number of the Monadelphous plants, though they have constructed their methods upon principles very different from those which L. has made choice of, in the establishment of his sexual method. The Monadelphous plants are arranged by Tournefort in the sixth section of his first class. Haller has thrown them into an order *(Columniferæ)* of his eighth class. By L. the greater number of the genera of this class are arranged under his thirty-seventh natural order, *(Columniferæ,*†*)* which was formerly mentioned. The genus Geranium, however, is referred to the fourteenth order of the same writer, the order *Gruinales,*‡ whilst several genera, not belonging to the class Monadelphia, are thrown into the order Columniferæ. In the system of Jussieu, these plants constitute an order called *Malvaceæ*, the fourteenth order of the thirteenth class. They constitute the fourteenth order of Van Royen's system by the English botanists, these plants are generally denominated *Malvaceous Plants*, and plants of the *Mallow-tribe.* The "natural classical character" (as L. calls it) of Monadelphia, is now to be mentioned. The vegetables of this class have in general, a permanent calyx, which in many of the genera, is double. In other genera, however, of the class, the calyx is single. Thus it is double in Malva, Alcea, &c. It is single in Gordonia, Morisonia, Stewartia, Adansonia, and others. The petals are five in number, and are somewhat heart-shaped, closely embracing each other above, so as to form the appearance of a single petal. Tournefort considered many of the Malvaceous plants as being monopetalous; but the corollo is unquestionably, polypetalous, although the petals when they fall, cohere together, which is owing to the intimate connection which subsists between the filaments and the petals. The petals, indeed, appear to be a continuation of the filaments, or the filaments a continuation of the petals. The filaments as has already been observed, are united into a bundle, or cylinder, below, but are separate above. The anthers are lightly attached to the filaments by the middle. The receptacle of the fructification, or that part to which the flower and fruit are attached, is prominent in the middle of the flower. The seeds are kidney-shaped. It has already been observed, that the order Columniferæ

* Genera Plantarum.

† *Columniferæ*, from *columna*, a pillar, and *fero*, to bear, or support: because the stamens and pistils of these plants exhibit the appearance of a column, or pillar, in the centre of the flower.

‡ *Gruinales*, from *grus*, a crane. "Erit mihi magnus Apollo, qui hujus Ordinis dicat characterem." Linnæi Prælectiones, &c. p. 325.

contains a number of genera which do not belong to the class Monadelphia, and that some of the plants of this class are not comprehended, by L. in the order Columniferæ. I shall, in this place, merely hint at the nature and properties of those plants of the order which are arranged under the class of Monadelphia. I have already made mention of the properties of some of the other genera, and shall hint at those of a few more, in treating of some of the subsequent classes.

The subjects of the class Monadelphia vary in size, from some of the smaller vegetables that are known to us, to several of the most stupendous trees that have, hitherto, been discovered. Thus, some of the creeping Mallows (Malva rotundifolia, &c. &c.) are low and very humble plants, which seldom arrive to the heighth of six inches: whilst the Silk-cotton tree (Bombax pentandrum) is so large, and spreads its branches so widely, that, according to William Bosman,* twenty thousand men, closely armed, might without inconvevience to one another, stand under its branches. This vast vegetable is a native of Africa (where the traveller just mentioned, saw it,) and of South America. The Adansonia digitata (Ethiopian Sour-gourd) is one of the most stupendous trees that is known to us. It is a native of Senegal in Africa. Some of these trees are known to acquire the diameter of twenty-five feet, or seventy-five feet in circumference. The Adansonia is, also, a tree which attains to a great age. In the year 1749, the learned Mr. Michael Adanson saw two of these trees, in the neighbourhood of Goree, upon one of which was inscribed the date of the fourteenth, and upon the other that of the fifteenth century! yet, there was good reason to suppose, that the trees were not young when the dates were cut. It may be conjectured, upon very plausable grounds, that these trees sometimes attain to the age of eight or nine hundred years: an immense period for the existence of any species of organized bodies!

The class Monadelphia is by no means the least important in the sexual system. On the contrary, it furnishes us with many valuable vegetables, some of them among the most valuable with which we are acquainted. The different species of Gossypium, or Cotton, are subjects of this class. The species which is at present, cultivated with so much success, in the United States, and with such great emolument to the country, is the Gossypium herbaceum, a native of the East Indies. It is not probable that this plant will ever be a staple article of any of the States of the American Union to the northward of Virginia; unless in process of time, an essential change shall take place in the climates of North America. Nevertheless it should be remembered that vegetables, of various kinds, do, by degrees, habituate themselves to climates, the seasons of which are in a great measure stationary. A remarkable instance of which we have in that truly beautiful vegetable the Franklinia altamaha,† which, since the period of its first introduction into

* "Veri amans homo," as Haller calls them.

† Gordonia pubescens of Aiton.

Pennsylvania, has altered the time of its flowering, by nearly two months. Owing to the large quantity of mild mucilage with which they abound, there can be little doubt, that many of the Monadelphous plants might be used, with great advantage, as articles of diet. Some of them, indeed, have been introduced into notice as delicacies of the table. We know not with certainty what plant it was which the Romans so greatly esteemed, and which Horace has characterized by the name of the "levis Malva," or Smooth-Mallow. We have good reason to belive, it was a plant of the class Monadelphia. The young and tender fruit of the Hibiscus esculentus, or Okra, is much esteemed as an article of diet in the United States. The Camellia, a shrub very nearly allied to the true Tea, belongs to this class, and its flowers are used by the Chinese, for the purpose of scenting Tea. The Fraklinia is also, closely allied to the Tea, and I greatly mistake if its leaves which are considerably astringent, might not be employed as a good substitute for the Teas, in common use. The class Monadelphia has given to the materia medica, but few important articles. Some species of Geranium, however, are entitled to the attention of physicians. I here particularly allude to the Geranium robertianum, or Herb-Robert, and the Geranium maculatum. The root of the last mentioned species, which is a very common plant in the United States, is very astringent, and has been found useful in the cholera morbus of children.* A decoction of the roots of a species of Napæa, which the negroes call Lass, is said to be a sovereign remedy in the venereal disease. For an illustration of the class Monadelphia, see Plate XX.

CLASS XVII.—DIADELPHIA.

The seventeenth class of the sexual system is denominated Diadelphia.† By the English botanists, it is called the class of Two Brotherhoods. This class contains those hermaphrodite flowers, which have their stamens united below into two sets of cylindrical filaments. So much, at least, is implied by the name of the class; but, unfortunately the student will often find, that the plant which the Swedish naturalist has referred to this great section of his sexual method, has strictly speaking only one set of united filaments. In many of the genera, the stamens are all united; that is, all in one set, generally with a slit down the upper side of the tube. "These (says a very respectable botanist‡) really are not Diadelphous but Monadelphous, and are a great stumbling block to accurate beginners." &c. I cannot help adding in the words of Dr. Milne, "that the names given by former botanists, to the numerous

* See Collections for an Essay, &c. &c. page 8.

† From δις, twice, and αδελφος, a brother.

‡ Dr. J. E. Smith.

class of plants in question, are much more characteristic of their nature and appearance than that of Diadelphia.—In fact (to continue the words of the same writer,) the figure of the flowers and the fruit" of the vegetables of this class "never varies; the latter being always of the pod-kind; the former of the butterfly-shape. On the other hand, the two sets of united stamina, the only classic character expressed in the Linnæan title, are never to be traced without difficulty; for one of the sets only are properly united; the other consisting of a single filament, which, in most plants, adheres so closely to its kindred set, that it cannot be separated without the application of a pin or needle for that purpose. In some even no separation can be effected by this means."*

The orders or secondary divisions, of the class Diadelphia are founded on the number of the stamens, considered as distinct. Some of the Diadelphous plants have five stamens, some have six, some eight and some ten of these organs.

Pentandria.—This order contains only one genus, Monnieria, a rare South American plant.

Hexandria.—The two genera Fumária and Saraca belong to this order.

Octandria.—This order contains four genera, viz. Polygala, Securidaca, Dalbergia, and Cumaruna.

Decandria.—This is a very extensive and interesting order, and contains the following, among other, genera: viz. Nissolia, Pterocarpus, Amorpha, Ebenus, Erythrina, Abrus, Spartium, Genista, Lupinus, Anthyllis, Piscidia, Borbonia, Ulex, Arachis, Aspalathus, Ononis, Crotalaria, Colutea, Phaseolus, Dolichos, Orobus, Pisum, Lathyrus, Vicia, Astragalus, Biserrula, Phaca, Psoralea, Trifolium, Glycyrrhiza, Æschynomene, Hedysarum, Coronilla, Ornithopus, Scorpiurus, Hippocrepis, Medicago, Trigonella, Glycine, Clitoria, Robinia, Indigofera, Cicer, Ervum, Liparia, Cytisus, Mullera, Galega, Lotus, Geoffroya, Smithia, &c. Many of the genera of this order, which is the most natural assemblage of the class, have all the stamens united. Such are Spartium, Genista, and Ulex.

Character.—The class Diadelphia is in a great measure a natural class. The structure and general aspect of the plants which it embraces, are upon the whole, very similar; and I know not, that the class embraces a single species which might not, with propriety, be thrown into a class professedly natural. Accordingly, we find that, a number of botanists, whose views in the construction of their methods, or system, were very different from those of L. have associated together the Diadelphous plants under their natural orders. These plants correspond to the *Leguminosæ*, or plants having legumes, of Morison, Hermann, Boerhaave, Ray, and Royen: the *Tetrapetali irregulares* of Rivinus and Christopher Knaut: the *Tetrapetali difformes* of Christian Knaut; and the

* Botanical Dictionary, &c. article Diadelphia.

Papilionacei, or Butterfly-shaped flowers, of Tournefort and Pontedera. The Diadelphous plants are arranged by L. in his thirty-second natural order, *Papilionaceæ;* and by Mr. De Jussieu in his vast order, *Leguminosæ:* the eleventh order of his fourteenth class. It is to be observed, that beside the plants of the Linnæan class of Diadelphia, this order embraces a number of genera, which L. has thrown into other classes of his sexual method: such as Sophora, Anagyris, Cercis, Rauhinia, Hymenæa, Poinciana, Parkinsonia, Cæsalpina, Cassia, Guilandina, Cynometra, Prosopis, Adenanthera, Hæmatoxylum, which all belong as we have already seen, to the class Decandria. On the other hand, the order in question contains the genera Mimosa, Gleditsia, Tamarindus, &c. &c., which belong to other Linnæan classes. Some of these genera could not, with any propriety, have been thrown into the class Diadelphia: but L. might, without any violation to his system, have associated with the plants of this class, the plants of the first order of the class Decandria, with several irregular petals, such as Cassia, Anagyris, Cercis, and others, which have already been treated of. Indeed, one of the many objections which may be urged against the sexual system is this, that plants so closely allied to each other as are the Lomentaceous plants of Decandria and the Papilionaceous plants of Diadelphia, should be so widely separated from each other, and with such heterogeneous intervals, as they are. The class Diadelphia is, in several respects, one of the most important in the sexual system. It embraces a considerable number of vegetables, which constitute valuable articles of food to man, and many other animals. The seeds of some of these vegetables, such as various species of Pisum, Phaseolus, Dolichos, Lathyrus, Vicia, are among the number of the most nutritious articles with which we are acquainted. In these the farinaceous matter is combined with a large proportion of mild oil, and with the saccharine principle, or sugar. Hence, they contain three of the most nutritious principles of vegetable matters, that are known to us. Almost all nations, however rude, have turned their attention to the cultivation of some of these Diadelphous plants. When Ferdinand de Soto marched his army into Florida, before the middle of the sixteenth century, he often found the granaries of the natives well stored with Indian corn and certain leguminous seeds, which were, doubtless, those of some species of Dolichos: for to this day, the natives of the country cultivate several species of this genus of plants.—Considering the highly nutritious nature of the Leguminous plants, it is difficult to conceive the reason why Pythagoras who, by his religion was prohibited from the use of animal food, should have inflicted a curse upon one of these vegetables. On this subject the late Mr. James Bruce has offered an ingenious opinion. This class furnishes us with some very valuable medicines. The principal of these belong to the genera, Fumaria, Polygala, Glycyrrhiza, Galega, and Geoffroya. The Common or Officinal Fumitory (Fumaria officinalis) though but little used,

is, unquestionably, an active and valuable medicine. The Seneca Snake-root (Polygala Senega) is one of the most invaluable articles of the materia medica. It is peculiarly useful in the diseases of cynanche trachealis, croupe, or hives; in certain states of peripneumonia, or pleurisy, and in dropsical affections. Its great virtues as a remedy for the cure of the bite of the rattle-snake may, I believe, be safely called in question. And yet I have received certain information of the cure of a case of tetanus, or lock-jaw (occasioned by the bite of this reptile) by means of the Seneca. The root of Galega virginica is employed, in some parts of the United States, as a remedy against worms.—The bark of the Cabbage-tree (Geoffroya inermis) is used, with the same intention in the West Indies. The down or pubescence which covers the legume of the Cow-itch* (Dolichos pruriens) is one of the *very few* articles of the materia medica, whose *precise* mode of operation is known to us. This down is found to be a powerful anthelmintic. There can be no doubt, that its operation is purely *mechanical.* This is by no means a full list of the medicinal articles of the class Diadelphia. Several others might be mentioned.† But it will be more advantageous to observe, that this class furnishes us with some very important *plantæ tinctoriæ,* or dying plants. Such is the Indigofera tinctoria. From the leaves and small branches of this vegetable, which is a native of India, is prepared that valuable dye which is well known by the name of Indigo. It may not be improper to mention, in this place, that from the leaves, &c. of the Podalyria tinctoria, or Wild-Indigo, formerly mentioned, a coarse, somewhat violet-coloured, *fecula,* which was applied to the purposes of indigo, was prepared by the people in some parts of the United States, during the time of the revolutionary war. The branches of Genista tinctoria, or Dier's-Broom, are employed to give a yellow colour. From the leaves of Scorpion Senna (Coronilla Emerus) a dye is procured, by fermentation. It has too frequently been observed, that the plants of the class Diadelphia are of a mild nature; or, at least, destitute of very active properties. L. asserts, that, "in the whole order of Papilionaceæ, there is not one poisonous plant, with the exception of the seeds of the Lupin (Lupinus,) which kill the Hippopotamus, and which the domestic fowl refuse to eat." A later writer‡ has asserted, that the "plants of this class are scarcely any of them noxious to the larger animals, though some Gallegæ intoxicate fish." But it may safely be asserted, that a

* In some parts of Virginia, certain species of Rhus, or Sumach (particularly, I believe, R. radicans) are known by this name.

† L. has asserted, that "there is hardly one medicinal article in the order Papilionaceæ, the Liquorice, (Glycyrrhiza) excepted !!" *Prælectiones* &c. p. 419. When the Swede delivered this observation to his pupils, the medical properties of Fumaria officinalis, Polygala Senega, not to mention several others, were pretty well established.

‡ Dr. J. E. Smith.

good many of the Diadelphous plants are endowed with poisonous or very active powers. Thus, the property of the Geoffroya and Galega virginica, in destroying the human intestinal worms, must, I think be ascribed to a deleterious, or active quality attached to these vegetables. A species of Eastern Astragalus is remarkably caustic. The bark of Piscidia Erythrina, a native of the West Indies, intoxicates fish; as do some species of Galega. The seeds of the Blue Chickling-Vetch, (Lathyrus sativus,) those of the Dwarf Chickling-Vetch (L. Cicera,) and of Officinal Tare (Ervum Ervilia,) are said to be very prejudicial, when they have been eaten for a long time. The first of these plants is supposed, at Florence, to soften the bones and to occasion death. George D. Duvernoi has written an express dissertation concerning the poisonous quality of one of these vegetables.* It is a fact that some of the Leguminous plants prove very injurious to horses, and other large animals. The following Diadelphous genera are natives of the United States: viz. Corydalis Fumaria, Polygala, Erythrina, Amorpha, Crotalaria, Lupinus, Phaseolus, Dolichos, Glycine, Galactia, Clitoria, Pisum, Lathyrus, Vicia, Robinia, Æschynomene, Stylosanthes, Galega, Zornia, Hedysarum, Astragalus, Dalea (Petalostemum, *Mich*,) Psoralea, Trifolium, Medicago. The United States are extremely rich in the species of some of these genera, particularly Polygala, and Hedysarum: A complete history of the North American species of the last genus, would be a most valuable present to the botanists.—For an illustration of the class Diadelphia, see Plate XXI.

CLASS XVIII.—POLYADELPHIA.

The eighteenth class is denominated Polyadelphia.† By certain English botanists, this is called the class of Many Brotherhoods. It embraces those hermaphrodite plants, whose flowers have the stamens, or male organs, united by their filaments into three, or more, distinct bundles. The orders of this class are founded upon the number or insertion of the stamens: though it must be confessed, that this latter circumstance was not attended to by L. This naturalist constitutes four orders, but the whole of these it does not appear proper to retain.‡

* De Lathyri quadam venenata specie in Comitatu Montbelgardensi culta. Basiliæ: 1770. 4to.

† From Πολυς, many, and, αδελφος, a brother.

‡ The four orders of L. are Pentandria, Dodecandria, Icosandria, and Polyandria. "No part of the Linnæan system (observes Dr. Smith,) has been less accurately defined or understood than the orders of the eighteenth class. Willdenow, aware of this, has made some improvements, but they appear to me not sufficient, and I venture to propose the following arrangement: viz. 1. Dodecandria, 2. Icosandria, 3. Polyandria."—I retain these orders to which I have added Enneandria, especially as I think that Hypericum virginicum might,

Enneandria.—It seems almost absolutely necessary to give place to this order, not noticed in the arrangements of L. Willdenow, Smith, or any other systematic botanist. Here I would place the pretty Hypericum virginicum,* which is one of the finest illustrations of the class Polyadelphia. This plant has exactly nine stamens, most distinctly disposed of in three *phalanges*, each consisting of three stamens.

Dodecandria.—Here we find a few plants, which have from twelve to twenty, or twenty-five, stamens, or rather anthers. Theobroma Cacao, or the Chocolate-tree of America. *Merian. Surin t.* 26. 63. *Lamarck, Encycl. t.* 635. Abroma, *Jacq. Hort. Vindb. v.*3.*t.*1. *Miller, Illustr. t.* 63. Monsonia, *Curt. Mag. t.* 73. *Lamarck, t.* 638. This last plant has been removed by Schreber and Willdenow, to Monadelphia; but, according to Smith and others, more properly belongs to Polyadelphia. The genus Citrus, comprehending the Orange, the Lemon, the Shadock, &c. also belongs here, though referred by L. &c., to the order Icosandria. The insertion of the stamens of these plants into a proper receptacle, and not into a calyx, shows that they are more truly polyandrous than Icosandrous plants:—but it would be better to throw them into the order Polyandria of this class.

Icosandria.—The plants of this class have many stamens, their filaments, disposed of in several parcels, being inserted into the calyx, as in the legitimate members of the class of Icosandria. To this order Willdenow and Smith refer the genus Melaleuca, whch had formerly stood in the class of Polyandria: but which Persoon has placed in the class and order of Icosandria Monogynia. To Polyandria it does not belong: to Icosandria, we must refer it, if the class of Polyadelphia be abolished.

Polyandria.—Several genera belong to this order: their stamens are, for the most part numerous, and they have no connection with the calyx. The most extensive genus of the order is Hypericum, whose stamens are united into three or five parcels, corresponding with the number of the styles.—I have already said, that Hypericum virginicum has but nine stamens.—Munchhausia, which used to stand here, is a species of Lagerstromia, and is properly referred by Persoon to Polyandria Monogynia, "L. (says Smith) seems to have intended bringing Thea into this order." He originally considered Gordonia Lasianthus (which he took to be an Hypericum) as belonging to this class: and so I think it does, together with the magnificent Franklinia (Lacathaea florida of Salisbury, *Parad. Lond. t.*), if the class Polyadelphia is to stand. —Ascyrum, and Hopea, or Symplocos.

with some propriety, be separated from the other Hyperica, and made a new genus. Persoon has entirely abolished the whole class: and upon the whole, I think, he has shown his sense in so doing. Besides the orders Dodecandria, Icosandria, and Polyandria, Willdenow has an order Decandria, to which he refers Theobroma.

* Grows in wet grounds, in many parts of the United States.

Character.—The class Polyadelphia has but little claim to the character of a natural class.* The genera which it contains belong to very different natural orders of the botanists. Thus, the genera Theobroma, Abroma, and Symplocos, belong to the great order Columniferæ, already mentioned. The two first of these genera belong to Jussieu's order, Malvaceæ, Monsonia is referred by L. to his order Gruinales. Citrus belongs to the order Bicornes. Hypericum and Ascyrum belong to the order Rotaceæ.† The genera Ascyrum and Hypericum belong to Mr. De Jusseu's order *Hyperica:* the eighth order of his thirteenth class. Melaleuca is referred to the fine order *Myrti*. As this is one of the smallest, so it is also, one of the least important classes of the sexual system. Nevertheless, it furnishes us with some vegetables which those who are attached to the luxuries of the table would be unwilling to forego. That highly nutritious and agreeable article chocolate is prepared from the nuts of the Theobroma Cacao, which is a native of Mexico, and of different parts of South America. L. it has been observed,‡ must have been attached to the use of this article, as he has given to it a name which imports nothing less than the "food of the gods."§ The Swedish naturalist|| has attributed to this drink, good effects in curing certain diseases, which, by my own experience, I am led to believe are increased by the stimulus and full nourishment, which chocolate gives. The different species of Orange are some of the finest and most wholesome fruits that have, hitherto, been discovered. We derive no indispensible, or highly important, medicinal article from the class Polyadelphia. A species of Melaleuca,¶ indeed, furnishes us with the *oleum Caieput*, which is said to have been found useful in the cure of pertussis, or Hooping-cough, intermittents, and other diseases. Hypericum perforatum, or Common St. John's wort, was once deemed an article well entitled to the attention of physicians. But, at present, it is very generally, perhaps too much neglected. From a species of this genus, the Hypericum bacciferum, we obtain one of the varieties of Gamboge, that are in use. I have been

* "A small and rather unnatural class." Dr. J. E. Smith.

† So called from *rota* a wheel.

‡ By my amiable friend the late Mr. Pennant.

§ Theobroma, from Θεος, god, and Βρωμα, food.

|| See Amoenitates Academicæ. Vol. vii.

¶ Melaleuca Leucadendron?

* * * *

I have already said, that Persoon has entirely abolished the whole class of Polyadelphia. Brotero, in his *Flora Lusitanica* (Olisipone: 1804) has done the same. It is to be observed, however, that this author retains none of the Linnæan classes, as distinct classes, from his eleventh class of *Polyantheria* (which includes the two Linnæan classes of Icosandria and Polyandria) down to his class of *Cryptanthesia*, which corresponds to the class Cryptogamia of the Swedish botanist.

informed that Hopea tinctoria (I think the leaves) has been used, with advantage, in cases of nephritis, or calculus. We are more certain, that the leaves of this shrub are employed in some parts of the United States, to give a fine yellow colour. The Hopea, which is known by the names of "Yellow-leaf" and "Horse-Sugar," has been discovered in the United States as far north as about the latitude of thirty-nine. The following genera, belonging to this class, are natives of the United States; viz. Hopea, Hypericum, and Ascyrum. The North American species of Hypericum have not been sufficiently investigated. The Orange, the Lemon, and other species of Citrus, are not natives of the new world. They were introduced into this continent from the Canaries, but now prosper so well in many parts of America, that even North America may boast of its Orange-groves, not perhaps, inferior to those of the native countries of this vegetable. For an illustration of the class Polyadelphia, see Plate XIX. Fig. 2.

CLASS XIX.—SYNGENESIA.

The nineteenth class is denominated Syngenesia.* This by certain English botanists,† is called the class of Confederate males. This vast class comprehends those hermaphrodite flowers, in which the anthers, or male organs of generation, are united into a cylinder, whilst the filaments by which they are supported, are separate and distinct. The orders or secondary divisions, of this great class of plants arise from the different modes of intercommunication of the florets, or lesser partial flowers, which are contained within a common calyx *(perianthium commune.)* This intercommunication is denominated by the Swedish naturalist, polygamia florum, or the Polygamy of flowers. It admits of four cases or varieties, which will be particularly noticed in characterizing the orders of the class. L. has subdivided this class into six orders, viz. polygamia æqualis, polygamia superflua, polygamia frustranea, polygamia necessaria, polygamia segregata, and monogamia.

Polygamia aequalis.—In the plants which belong to this first order, the florets, or partial flowers, are all hermaphrodites, that is furnished with both stamens and style. Hence, as there is no difference in respect to the potential perfection of the different florets, the Polygamy is said to be equal. The propriety of this species of language (however it may have been objected to) will hardly be denied by those, who admit the truth of the doctrine, that the stamens and the pistils are the male and female generative organs of vegetables. This order contains the semifloscular *(semiflosculosi,)* and many of the floscular *(flosculosi)* compound flowers in the system of Tournefort. Most

* From συν, together, γενεσις, generation.

† Dr. Darwin, &c.

of these flowers are furnished with the ligulate, or strap-shaped, corolla, and a very few of them with a radiate corolla.

The following are the principal genera, which belong to the order: viz. Scolymus, Cichorium, Catananche, Seriola, Hypochoeris, Geropogon, Andryala, Tragopogon, Picris, Leontodon, Scorzonera, Crepis, Chondrilla, Prenanthes, Lactuca, Hieracium, Sonchus, Lapsana, Hyoseris, Atractylis, Barnadesia, Carlina, Cnicus, Arctium, Carthamus, Cynara, Carduus, Onopordum, Serratula, Ethulia, Spilanthus, Ageratum, Cacalia, Chrysocoma, Eupatorium, Kuhnia, Santolina, Calea, Athanasia, Bidens, Stæhelina, Pteronia, Tarchonanthus.

Polygamia superflua.—In the plants of this order, the florets in the centre or disk, are hermaphrodite; while those of the circumference, margin, or radius, are simply female florets; that is, they are destitute of the stamens, or male organs. This species of intercommunication, or polygamy, is denominated Superfluous, because the impregnation of the female florets in the circumference is altogether unnecessary to the perpetuation of the vegetable by seed; the fructification being perfected in the florets of the centre.

To this order are referred the following among other genera: viz. Tanacetum, Artimesia, Gnaphalium, Xeranthemum, Carpesium, Baccharis, Conyza, Erigeron, Tussilago, Senecio, Aster, Solidago, Cineraria, Inula, Arnica, Doronicum, Perdicium, Helenium, Bellis; Bellium, Tagetes, Leysera, Zinnia, Pectis, Chrysanthemum, Matricaria, Cotula, Anacyclus, Anthemis, Achillea, Tridax, Amellus, Eclipta, Sigesbeckia, Verbesina, Buphthalmum, Unxia, and Mutisia.

Polygamia frustranea.—This order furnishes us with the third case of Polygamy of flowers. For here the hollow florets in the disk or centre of the flower are supplied with both the stamens and style, while the flat florets in the radius or circumference, are neuter, that is, are destitute of both the stamens and styles or male and female organs. To this species of polygamy, L. has, I think, very properly, given the name of frustraneous or ineffectual, because the florets, which are situated in the ray, being destitute of sexual organs, can be of no potential use in the function of generation. This order which is much less extensive than either of the preceding, contains the following genera, viz. Sclerocarpus, Helianthus, Rudbeckia, Coreopsis, Osmites, Gorteria, Zoegea, and Centaurea.

Polygamia necessaria.—In the plants of this order, the florets of the disk are male, or have stamens, whilst those of the ray are female, or merely supplied with the pistil. This species of polygamy is with great propriety, and indeed, very happily, denominated necessary, because neither the florets of the disk or ray being hermaphrodite, the intercommunication of the two sexes, situated in different parts of the flower, is absolutely necessary for perfecting the fructification. The greater number of the flowers of this order are radiate. This order embraces the genera Milleria, Baltimora, Silphium, Polymnia, Chryso-

gonum, Melampodium, Calendula, Arctotis, Osteospermum, Othonna, Hippia, Eriocephalus, Filago, and Micropus.

Polygamia segregata.—This order does not furnish a distinct case of polygamy. It is, in reality, only a modification of the first case, or necessary polygamy. In the greater number of the plants of the order of separate polygamy, the florets are hermaphrodite, as well as in those of the first order, but then they are separated from each other by means of partial flower-cups, or perianths, which support one or more florets, and are placed within a common calyx, or perianth. To this order belong the genera, Elephantopus, Oedera, Sphæranthus, Echinops, Gundelia, Stoebe, and Jungia.

Monogamia.—This sixth and last order contains simple flowers, in which respect it differs from all the preceding orders, the flowers of which are truly compound. In fact the genera which L. has referred to the order Monogamia which I am examining, are so essentially different in their structure and in their aspect, from the plants of the preceding five orders, that the Swedish naturalist has (to use the words of an author whom I have often quoted) offered "a manifest violence to Nature by forcibly tearing many genera of plants from their proper place, and incorporating them with others, which are of a different and even opposite nature. In fact (continues our author,) of all the numerous systems of botany, there is not a single character which wounds nature so cruelly as that of L. in the instance just given."* This criticism is not too severe. The value of the sexual system has, certainly been lessened, the number of its opponents (many of whom were ardently engaged in the pursuit of a natural method of plants) has been increased, by those monstrous deviations from nature, of which there are too many instances in the almost universally-received method of L. It must not, however, be supposed, that the Swedish naturalist has mixed and confounded the simple-flowered plants of the order Monogamia with the compound flowers of the preceding orders, without having proceeded upon a rule of *apparent* consistency, which he and his admirers have endeavoured to defend. The name of the class Syngensia imports an union of the anthers, or summits of the stamens. This may be said to be the classical character of the great body of plants which are associated under this class. Now, Balsam (Impatiens,) Cardinal-flower (Lobelia,) and the other plants of the order Monogamia, are said to agree with the compound flowers of the preceding orders, in the character in question. These simple-flowered plants are, therefore, thrown into the same great division of the sexual method, along with the others. So attentive, indeed, was L. to the circumstance of the union of the anthers, that he has detruded from its proper place, among the compound-flowers, a particular genus, that of Kuhnia, merely because the anthers of this plant are distinct; and has thrown it into the class of Pentandria, where it is no less monstrous-

* Dr. Milne. See his Botanical Dictionary, article Syngensia.

ly associated than are the genera Impatiens, Lobelia, &c., with the compound flowers of Syngenesia.* But it is not true, that the anthers of all the plants which L. has referred to the order Monogamia are united into a cylinder. On the contrary, the anthers are separate in many species of Lobelia and Violet. Again in some species of Solanum, or Nightshade, and in other genera, which are referred by L. to the class Pentandria, the anthers are actually connate, or united into a cylinder!! Some of the warmest admirers of L. and those who have manifested the least disposition to innovate the sexual system, have been obliged to forsake their great and successful leader, in the arrangement of the genera which he has referred to the order Monogamia. Thus, Dr. James Edward Smith, though he retains all the classes of L. that of Polygamia excepted, has, with great propriety, abolished the last order of Syngenesia, and referred the genera which it contains (in the method of L.) to the first order of Pentandria.† The following are the genera which L. has referred to the order Monogamia: viz. Strumphia, Seriphium, Corymbium, Jasione, Lobelia, Viola, and Impatiens.‡

Character.—The class Syngensia, with the exception of the order Monogamia, is a very natural assemblage of plants.§ It embraces the great family of compound flowers, which is unquestionably, a natural tribe, essentially distinct from the plants with simple flowers. The essence of these compound-flowers is said, by L. to consist in the two circumstances of the union of the anthers into a cylinder, and a single seed, placed below the receptacle, and attached to each floscule. The greater number of these plants are furnished with a common calyx, or perianth. In Echinops, however, the common calyx is wanting; and it is present in Scabiosa, which L. does not refer to the true compound-flowers; but to his forty-eighth order, or Aggregatæ. The compound-flowers are furnished with a common receptacle *(receptaculum commune.)* But Milleria, one of these plants, is destitute of the species of receptacle; and, on the other hand, we have instances of it in Scabiosa, Teasel (Dipsacus,) Globe-flower (Gomphrena,) though neither of these plants are referred, by L. to the head of compound-flowers. The botonists|| before the time of L. had sought for the essential character of the compound-flowers, in the presence of a common calyx and a common receptacle: but the Swedish naturalist rejects both

* Dr. Milne (not very consistently, I think, with the sentiments which he has delivered in other parts of his work) says that Kuhnia "is very properly referred by L. to a class containing simple flowers, because the *antheræ* are separate and distinct." Botanical Dictionary &c. article *Compositus Flos.*

† See this author's Flora Britannica, a work of extensive merit.

‡ These genera ought to have been mentioned in the list of the plants belonging to the first order of Pentandria.

§ "Classis hæc naturalis est, nisi ultimus accederet ordo, heic loci secundum assumta principia Systematica necessarius." Genera Plantarum.

|| Tournefort, Vaillant, &c.

of these as inadequate to the purpose, and, in their place, substitutes the union of the anthers, and the situation of the seeds. In attending thus *exclusively* to these characters, I am inclined to think, that our author has too rudely refused the hand of nature.

The true Syngenesious plants are compound flowers, consisting of a number of individual floscules, or florets. The following features constitute the principal natural character of such a floscule. The calyx is a corona seminis, or aigrette, sitting upon the apex of the germ. The corolla is monopetalous, furnished with a long and very narrow tube, sitting upon the germen. This corolla is, 1. *tubulata*, tubulate; with a campanulate, or bell-shaped limb, quinquefid, the lacinæ reflex and spreading. 2. *ligulata* ligulate, or strap-shaped, the limb linear, flat, turned outwards, dentate, truncated. 3. or lastly, there is no corolla, being destitute of the limbs, and frequently of the tube also. The stamens, in the greater number of the species are five in number: they are capillary, very short and inserted in the neck of the corollula. The anthers, are, also, five in number: they are linea, erect, cohering, by their sides into a tubulose cylinder, which is quinquedentate, and of the length of the limb. In regard to the pistil: the germ is oblong, placed below the corollula, and above the common receptacle. The style is filiform, erect, of the length of the stamens, and perforates the cylinder formed by the anthers. The stigma is bipartite; the segments are revolute and spreading. These plants are destitute of a true pericarp, though in some of the genera as in Bone-seed (Osteospermum,) and strumpfia, the seed are enveloped in a coriaceous crust. There is a single seed which is oblong, often four-cornered, and frequently narrowed at the base. The greater number of the true Syngenesious plants, I mean those of all the orders except Monogamia, are referred by L. to his forty-ninth natural order, which he calls *Compositæ.* This order embraces not a single simple-flowered plant. Almost all the genera which it contains are referred by L. himself to his class, Syngenesia: but this order contains Kuhnia, which our author for reasons already mentioned, places among the Pentandrous plants. The Syngenesious plants are principally referred by Mr. De Jussieu to his order *Cichoraceæ, Cinarocephalæ,* and *Corymbiferæ*, the three first orders of his tenth class. In the construction of these orders, the learned French botanist has nearly followed the disposition of his learned countryman Vaillant who had paid great attention to the compound-flowers. Independently on their compound flowers, there is something in the aspect of the Syngensious plants which emphatically distinguishes them from all other plants. It is not easy to tell, what this something is. I think, it is Sir John Hill who has observed, that these plants have a kind of "weed-like appearance." There is much foundation for this observation. Notwithstanding the beauty of their flowers, the prevailing colours of which are yellow and orange, the stems and the leaves of a very great number of these plants are rough or downy, being beset

with different kinds of pubescence.* One would say, that they have been less completely reclaimed from their wild and savage state, than most other plants, with the exception of those of the XXIVth class. L. observes, that "there is no poisonous plant in the order Compositæ, with the exception of Tagetes, Doronicum, and Arnica."† It may be doubted, whether Arnica be more poisonous than many of the other bitter articles of this class. Lactuca, virosa is a narcotic plant, and a good opium has been procured from the Common Garden-Lettuce (Lactuca sativa.)‡ A good many of the Semifloscular plants of the first order are esculent. It is somewhat remarkable, that although the lactescent plants, or plants abounding in a milky juice, of the other classes, are very frequently poisonous, that the milky plants of Syngensia, with a very few exceptions, are entirely innocent. This circumstance will show the propriety of receiving, with hesitation, all those general canons, which have been proposed by the Materia Medica writers, respecting the properties of plants, as deduced from their general aspect, or obvious qualities. Nevertheless, the rule of L. ought to be remembered: viz. "Plantæ lactescentes plerumque venenatæ sunt."§ "In general, the lactescent plants are poisonous." Many of the bitter plants of this order are entirely destitute of any deleterious quality, indeed I have long since been persuaded contrary to the opinion of the late Dr. Cullen, that the deleterious quality which is found in so many bitters, is merely an accidental quality attached to those bitters, and that bitters, as bitters, are not necessarily injurious, even when long continued. The class syngensia is, in many respects, an important one. It furnishes us with many beautiful plants, and with not a few articles of diet and of medicine. So extensive, however is the class, that I shall principally confine myself, at present, to the mention of a very few of the medicinal articles which it embraces. The Common Dandelion (Leontodon Taraxacum) has been much celebrated as a diuretic and resolvent medicine. A species of Lettuce (Lactuca virosa) has been used in the same affections. Some species of Serratula and Eupatorium are entitled to the attention of Physicians.|| The famous Chamomile of the shops is the Anthemis nobilis. Different species of Colts-foot (particularly Tussilago Farfara and T. Petasites) have been deemed useful medicines. The wormwood of the shops is the Artemisia Absynthium. The Philadelphia Fleabane (Erigeron Philadelphicum) has acquired some reputation in the United States as a remedy in calculous or nephritic cases, and in gout.

* Among the compound-flowers of Syngensia, there are, however, many species with smooth and even shining leaves and stems.

† Prælectiones, &c. page 577.

‡ See Transactions of the American Philosophical Society, Vol. IV. No. LXIV.

§ Caroli a Linne, Materia Medica. Liber primus de Plantis. Amstelædami: 1749.

|| See Collections for an Essay, &c. &c. pages 27, 35, 52, 53.

In hinting at the properties of the plants of the class Pentandria, I omitted to take any notice of the genera referred to by L. to the order Monogamia of the class Syngenesia. Some of these plants have been the subjects of inquiry among physicians and others. Some of the species of Lobelia, particularly L. siphilitica, and L. Cardinalis, are found to be endued with active qualities. Some species of Viola are also active plants, particularly V. Ipecacuanha.

The United States are extremely rich in the plants of the class Syngenesia. Indeed, I believe, there is no tract of country, of an equal extent, which is so abundant in plants of this class. The species of the North American Syngenesious genera are very numerous, and are by no means well defined. There are reasons to believe that many of these species are hybrids, or mules. For illustrations of the class Syngenesia, see Plates XXII, XXIII, XXIV.

CLASS XX.—GYNANDRIA.

The twentieth class is called Gynandria.* Dr. Darwin names this class Femenine Males. It contains those hermaphrodite flowers, in which the stamens are placed upon the style: or to speak more properly, upon a pillar-shaped receptacle, resembling a style, which rises in the centre of the flower, and supports both the stamens and the pistil.

The orders of this class are founded upon the number of the stamens or male organs. L. has subdivided the whole class into nine orders, viz. *Diandria*, *Triandria*, *Tetrandria*, *Pentandria*, *Hexandria*, *Octandria*, *Decandria*, *Dodecandria*, and *Polyandria*. In this disposition of the Gynandrous plants most of the botanists (I mean those who have retained a distinct class by the name of Gynandria) have followed L. But the learned Professor Swartz, of Stockholm, who has devoted very particular attention to the plants which I am considering, has shown, that what has generally been taken for two anthers is nothing more than a single anther bilobated, or consisting of two lobes, and consequently, that the greater number of the genera which L. has thrown into the order Diandria of this class, must be referred to the order Monandria. I adopt Swartz's alteration.

Monandria.—To this order Swartz refers the following genera, viz. Orchis, Disa, Satyrium, Pterygodium, Disperis, Corycium, Ophrys, Serapias, Neottia, Cranichis, Thelymitra, Diuris, Arethusa, Epipactis, Malaxis, Cymbidium, Oncidium, Epidendrun, Vanilla, Aerides, Limodorum, Dendrobium, Stelis, Leptantes.†

Diandria.—L. and other writers have referred to this order, a number

* From γυνη, a woman, and ανηρ, a man.

† Several of these genera are new ones, constructed by Mr. Swartz. It is not to be supposed that this author's innovations will be implicitly received by *all* botanists. The botanists, like the the chemists, are fond of revolutions.

of genera, most of which are now found to belong to the preceding order of Monandria. Of all these genera, Swartz is of opinion, that one only belongs to the second order. This is the genus Cypripedium.

Triandria.—The genera Sisyrinchium, Ferraria, Salacia, and Stilago, belong to this order. The two first mentioned genera are, more properly Monadelphous plants. Stilago turns out to be the male of Antidesma.

Tetrandria.—The genus Nepenthes belongs to this order. I have mentioned this singular plant in a former part of the work.

Pentandria.—The three genera Gluta, Ayenia, and Passiflora, which were originally placed here, are not gynandrous; for their stamens are inserted below the germen, merely on a columnar receptacle. Schreber and Smith have, therefore, referred these plants to the class Pentandria. On the other hand, Willdenow and Persoon, two not less able judges, have placed Passiflora in the order of Pentandria of the class Monadelphia, where I think it more truly and naturally belongs. They refer the two other plants to Pentandria Monogynia.

In Persoon's list, therefore, the order Pentandria is abolished. But Dr. Smith fancies, that it may still exist, by "a reinforcement from the Linnæn Pentandria Digynia." Perhaps, Pergularia, Cynanchum, and Asclepias.

Hexandria.—Here we find the great genus Aristolochia, still imperfectly explored. Not a few of its species are natives of the United States, and other parts of America. Pistia, which was formerly placed in the order, is referred to Monadelphia Octandria. But its place is supplied by Bragantia, a genus from Loureiro.

Octandria.—Here L. placed Scopolia: but this turns out to be a Daphne. Still it is thought that the order may remain, since the parasitical Cytinus, formerly mentioned,* which had been referred to the order of Dodecandria, is said to have only eight anthers, which are truly inserted upon the style. Cytinus, however, is placed by Persoon in Monoecia Monadelphia. And this author retains no order of Octandria for *entire* genera.

Decandria.—This order is now abolished. The two genera which it formerly contained, viz. Kleinhovia and Helicteres, are elsewhere disposed of. The former genus, according to Smith, belongs to the class Dodecandria, as having fifteen stamens; the latter Decandria Monogynia: but Persoon and others have found a better place for them in the order Dodecandria of the class Monadelphia. I would refer them to the order Polyandria of that class.

Dodecandria.—This order is abolished.

Polyandria.—Smith, Persoon, and others, have abolished this order, and have referred the genera which it contained to other classes of the system. Thus Xylopia is thrown into Polyandria Polygynia, near to Annona, Porcelia, &c.; Grewia to the first order of the same class, Pothos to the class Tetrandria; Dracontium to Heptandria, and Arum to Monoecia Polyandria.

* Asarum Hypocistis of L. It is the Cytinus Hypocistis.

I am far from being satisfied that all these removals are real improvements: for the number of the stamens is not constant in the different species of Pothos, Dracontium* and Calla. And as to Arum, some species are, I think, truly Gynandrous, and others Dioecious. I shall speak of the properties of some of the plants just mentioned, as though they were legitimate representatives of the class Gynandria.

Gynandria is the first of the twenty-four classes which Professor Thunberg has abolished. The genera which the class contained are referred by this very respectable botanist to preceding classes of the sexual system. But of this alteration, more afterwards.

Character.—This "odd and miscellaneous class" has not much claim to the character of a natural class. L. however, deemed the first order, which he called Diandria, a natural assemblage of plants. They constitute his seventh natural order, named *Orchideæ.* They constitute an order, of the same name, in the system of Mr. de Jussieu. It is the third order of his fourth class. Arisctolochia, together with Asarum of the eleventh, and Cytinus of the twenty-first class, belong, in the system of Jussieu, to an order called *Aristolochiæ.* It is the first order of this botanist's fifth class. Pothos, Dracontium, Calla, Arum, Ambrosinia, and Zostera are arranged in the order Piperitæ, of which I have already made particular mention. Jussieu refers these plants, together with Orontium (Golden Club,) and Acorus, of the sixth class, to an order called *Aroideæ.* In regard to their properties, many of the Gynandrous plants, particularly those of the order Orchideæ, have, for a long time, maintained the reputation of being aphrodisiack. But it may well be doubted, if there be any foundation whatever for this character.† It seems to have originated in those dark ages, when the doctrine of Signatures, which is altogether unworthy the notice of an enlightened people, exerted its influence upon the minds of men. It must not be denied, however, that from some of these plants, we obtain extremely nutritious articles. Thus, the Salep of the shops is the produce of the Orchis Morio; and it has been shown, that from the bulbs of other species a very good salep might be produced. Very miscellaneous are the other genera of this class. It, certainly, however, contains a number of very active plants, and therefore remote from the Orchideæ. The genera Arum, Dracontium, Pothos, and Calla, are acrid vegetables, which in their *recent* state, do, unquestionably, exert powerful effects upon the system. The properties of the Indian Turnip (Arum triphyllum) of the United States, have been attended to.‡ The fresh root of this plant, boiled in milk, and thus taken for some time, has been found useful in consumption of

* In Pothos putorii, as I call it, (Dracontium fœtidum of L.) the stamens are constantly four in number. See my *Flora Virginica, Part* 1. *p.* 57, 58.

† In some parts of the United States, the roots of a species of Cypripedium (C. pubescens, *Mich.*) are reputed emmenagogue.

‡ See Collections for an essay, &c. Part 1. pages 21, 52.

the lungs. When fresh, Pothos putorii, called Skunk-Cabbage, and Polecat-weed, is an extremely powerful plant. The bear* of North-America is well acquainted with the purgative property of this vegetable. The Aristolochia Serpentaria is the celebrated Virginia Snake-root, a medicinal article of real value. The root of another species of the genus, the Aristolochia Sipho, is entitled to the attention of physicians. The pods of the Epidendrum Vanilla of L. (vanilla aromatica of Swartz) have a very agreeable taste, and smell. They are one of the articles in the materia medica of the Mexians, and enter into the composition of chocolate.

The United States are pretty rich in the plants of the class Gynandria. This tract of country contains, at least the following genera, viz. Orchis, Satyrium, Ophrys, Serapias, Neottia, Arethusa, Epipactis, Malaxis, Cymbidium, Limodorum, Cypripedium, Aristolochia, and Arum. For illustrations of the class Gynandria, see Plates XXV, and XXVI.

CLASS XXI.—MONOECIA.

The class Monoecia,† the twenty-first of the sexual system, is essentially distinguished from all the preceding classes. It embraces those vegetables, in which the male and female flowers, in other words the stamens and the styles are placed *apart*; that is within distinct covers (calyx or corolla, or both) on the *same* root, or individual. This peculiarity of disposition in regard to the generative organs, led L. to name this class Monoecia; and some of the English botanists, the class of one house. From what has just been said it is evident, that the plants of the class under consideration are not hermaphrodite, as are the plants of the preceding twenty classes:‡ nor are the stamens or the styles, or male and female organs, situated upon *distinct* individuals of the same species, as in the next class, or Dioecia. The plants of Monoecia are androgynous§ that is, consist of male and female flowers upon different parts of the same plant. The orders of this class are eleven in number; and are founded upon the circumstance of the number; the union, and the situation of the stamens, and are distinguished by the names of the preceding classes. The following are the orders: viz. Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Heptandria, Polyandria, Monadelphia, Syngenesia, and Gynandria.

Monandria.—This order contains the genera Chara, Caulinia, Zannichellia, Ceratocarpus, Artocarpus, Elaterium, Cynomorium, Phyllachne, Casuarina, and Ægopricon.

* Ursus Americanus of Gmelin.

† From μονος, alone, and οικια, a house, or habitation.

‡ Many individual species, however, of the preceding classes do, in strict propriety, belong to the class Monoecia.

§ From ανηρ, and man, and γυνη, a woman.

Diandria.—The genera Anguria, Lemna, and Podostemum belong to this order.

Triandria.—To this order belong the following genera: viz. Zea, Tripsacum, Coix, Olyra, Zeugites, Kobresia, Carex, Scleria, Sparganium, Typha, Axyris, Comptonia, Tragia, Hernandia, and Acharia. Various species of Amaranthus belong to this order. The genus is referred to the order Pentandria.

Tetrandria.—The genera Urtica, Diotis, Morus, Buxus, Pachysandra, Betula, Alnus, Serpicula, Aucuba, Littorella, and Cicca, belong to this order.

Pentandria.—To this order belong the following genera, viz. Nephelium, Schisandra, Xanthium, Ambrosia, Parthenium, Clibadium, Crotonopsis, Iva, Amaranthus, and Leea.

Hexandria.—Zizania and Pharus, which are both grasses, belong to this order.—Concerning Zizania, See my *Fragments.* &c. Part 1. Tables, pages, 6. &c.

Heptandria.—The genus Guettarda belongs to this order.

Polyandria.—To this order, which contains those genera that have more than seven stamens, belong the following genera: viz. Begonia, Sagittaria, Myriophyllum, Ceratophyllum, Theligonum, Poterium, Castanea Fagus, Quercus, Juglans, Corylus, Carpinus, Platanus, Liquidambar.

Monadelphia.—The character of the male flowers of this order is the same as that of the true Monadelphous plants of the XVIth class; that is, the filaments are united into a bundle below, whilst the anthers are separate. Hence those writers who have suppressed the class Monoecia, have referred the plants of the order under consideration to the class Monadelphia.

The following genera belong to this order, viz. Hura, Pinus, Cupressus, Thuja, Acalypha, Dalechampia, Plukenetia, Cupania, Croton, Ricinus, Siphonia, Jatropha, Sterculia, Hippomane, Stillingia and Gnetum.

Syngensia.—To this order are referred the genera Trichosanthes, Momordica, Cucumis, Cucurbita, Sicyos, and Bryonia, the anthers of which, like those of the true Syngenesious plants, are united into a cylinder, while the filaments are distinct.

Gynandria.—This has been very properly denominated "a paradoxical order."* How, indeed, can a plant belong to the class Monoecia, the character of which is to have the male and the female *organa sexualia* in different covers of the same vegetable, and yet answer to the character of the class Gynandria, the peculiar feature of which is to have the male organs in question attached to the female, within the same calyx, or corolla? I confess that I am at a loss to understand the Linnean disposition in this respect, and I cannot believe that L. understood it himself. Bastard Orpine (Andrachne) one of the plants referred to this

* Dr. J. E. Smith.

order, has the stamens placed upon the female organ; "a circumstance which involves an absurdity when affirmed of any plant of the class in question, and which, if true, should most certainly have determined the author to place the genus in the class Gynandria."* &c.

Notwithstanding the preposterous character of this order of the class Monoecia, the learned Professor Gouan, of Montpelier, has endeavored to show, that there is good foundation for the establishment of such an order. The professor observes, that both in Bastard-Orpine, and in Clutia, the pistil, or female organ, is altogether wanting in the male flowers, yet the stamens are inserted into the same place, which the pistil would occupy, if the flowers were truly hermaphrodite. To illustrate this, the author considers the receptacle of the flower as divided into four concentric circles, thus, the calyx, or flower-cup, constitutes the first, or exterior circle; the petals occupy the second; the stamens are placed in the third; and the pistil possesses the inner, or middle circle. Hence it follows (our author observes,) that even when the stamens are inserted into the inner side of the petals they still occupy a circle, which is concentric to that of the petals, and placed exterior to that of the pistil. In such circumstances, therefore, the stamens cannot be reckoned out of their place. But if the middle circle, or centre of the receptacle, which is essentially destined for the pistil, should in the absence even of that organ, be occupied by the stamens, these last are then out of their place, and may properly be considered as being attached to the pistil, when inserted into the place, which that organ, if it did exist, would certainly occupy. I Have not, at present, an opportunity of consulting the original work† of Professor Gouan, in which is contained the preceding defence of the Swedish naturalist, in the establishment of the order Gynandria, of the class Monoecia. In the view which I have given of the subject, I have adopted, with little variation, the words of Dr. Milne, and I shall conclude what I have to say, on the subject of this order, with a quotation from this author's work. "I shall only observe upon this ingenious remark of the French author, that by the same way of reasoning all the plants of the classes Monoecia and Dioecia, might be referred to the class Gynandria, in the sexual method; as in these classes the female organ is entirely wanting in the male plants, and the stamina occupy the centre or middle of the receptacle."‡ Two Genera are referred to the order Gynandria, viz. Andrachne and Agyneja. The character of the last genus is very doubtful.

The class Monoecia has been abolished by Thunberg, Gmelin, and other writers.

Character.—The vegetables of the class Monoecia are arranged by L. and other witers under very different natural orders or families. Chara and Zannichellia belong to the Linnæn order, Inundatæ, formerly

* Dr. Milne. See his Botanical Dictionary, article Monoecia.

† I suppose, the Hortus Monspeliensis, &c. &c. Monspelii: 1762.

‡ Botanical Dictionary, &c. article Monoecia.

mentioned. Anguria, Trichosanthes, Momordica, Cucumis, Cucurbita, Sicyos, Bryonia, together with Passiflora of the preceding class, are referred to the thirty-fourth Linnæn order, *Cucurbitaceæ.* Mr. de Jussieu's order of the same name, comprehends these and other genera. Betula, Fagus, Quercus, Juglans, Corylus, Carpinus, and Platanus, belong to the fifteenth natural order, Amentaceæ. Pinus, Cupressus, Thuja, &c., are referred to the fifty-first natural order, Coniferæ. The orders Amentaceæ, and Coniferæ, in the method of Jussieu, embrace these genera. Zea, Tripsacum, Coix, Olyra, Zizania, and Pharus, are grasses, and belong to the order Gramina. Carex, Sparganium, and Typha, are of the third natural order, Calamariæ,* which are considerably allied to the Grasses. The United States contain a considerable number of the genera of this class. The following may be mentioned, viz. Chara, Lemna, Zea, Tripsacum, Carex, Sparganium, Typha, Urtica, Morus, Betula, Xanthium, Iva, Amaranthus, Zizania, Pharus, Sagittaria, Fagus, Quercus, Juglans, Corylus, Carpinus, Platanus, Liquidambar, Pinus, Cupressus, Thuja, Acalypha, Ricinus, Stillingia; Momordica, Curcubita, Sicyos, and Bryonia. All these are unquestionably, indigenous genera, within the limits of the United States, unless, perhaps, the two genera Zea and Cucurbita. The well known Indian-corn (Zea Mays) was only found in a cultivated state; and the same remark applies to the different species of Cucurbita, such as the Cu. lagenaria, or Calabash, C. pepo, or Pompion, and others. The American plants of this class, deserve more attention than has hitherto been bestowed upon them. The Oaks of this country have, indeed, been lately examined by Mr. Michaux, in a work which reflects honour upon that author. He has, however, omitted several of the American species of this genus. The genus Juglans deserves as much attention. It will, I think, be necessary to divide this genus into two distinct genera. The Chestnut of the United States is a species essentially distinct from that of the old world. I call it Castanea Americana: for I am persuaded that the Chestnut and the Beech ought not to be referred to the same genus. The Chinquepin of the United States (Castenea Chinquepin, *mihi*) is not a Fagus, but a Castanea. The Beech of North America is now acknowledged to be distinct from that of the old world. It is the Fagus ferruginea of L'Heritier. The American species of Birch and Alder cannot, with any propriety, be referred to the same genus. They belong to two distinct genera, viz. Betula and Almus. For illustrations of the class Monoecia, see Plates XXVII, and XXVIII.

* From *Calamus*, a reed.

CLASS XXII.—DIOECIA.

The twenty-second class is named Dioecia.* In English it is called the class of two houses. It contains those plants, which have no hermaphrodite flowers, but produce the male and female flowers on distinct individuals of the same species. Thus the character of this class is very essentially different from that of any of the preceding twenty-one classes: for in the first twenty of these the flowers were hermaphrodite, and in the twenty-first, male and female upon different parts of the same vegetable. But in the class now under consideration, the same individual does not support the two sexes.

The orders of the class Dioecia are fifteen in number and are founded upon the circumstances of the number, the union, and the situation of the stamens, or male organs: and of course upon the same principles, as the orders of Monoecia, and the classes which precede Monoecia. The following are the names of the orders of Dioecia; viz. *Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Octandria, Enneandria, Decandria, Dodecandria, Icosandria, Polyandria, Monadelphia, Syngenesia,* and *Gynandria.*

Monandria.—This order contains the genera Najas and Pandanus, and, also some new genera of Schreber.

Diandria.—Vallisneria, Cecropia, and Salix, are referred to this order.

Triandria.—Empetrum, Stilago, Osyris, Caturus, Excoecaria, Willdenowia, Elegia, Restio, and Maba, belong to this order. Here also Willdenow places the magnificent Phœnix.

Tetrandria.—Hippophæ†, Trophis, Viscum, Bruccea, Batis, Myrica, and Montinia, are of this order.

Various species of Nettle (Urtica,) Black Mulberry, (Morus nigra,) and some species of Buckthorn (Rhamnus,) belong to this order.

Pentandria.—To this order Willdenow refers Pistacia, Zanthoxylum, Astronium, Canarium, Antidesma, Iresine, Spinacia, Acnida, Cannabis, Humulus, Zanonia, and a few others. Smith observes, that "Humulus is almost the only certain instance here." But even the number of its stamens is by no means constant. He adds, "Spinacia, Acnida, and Cannabis would be unexceptionable, but they are less absolutely dioecious, being sometimes monoecious:" as I believe *most* dioecious plants are.

Phylica dioica, Rhamnus Alaternus, and Salix pentandra are, also, referred to this order.

* From δις, twice, and οικια, a house.

† Mr. Vibourg first, and since him myself, have found united flowers intermixed with the barren ones, in Hippophae. I examined H. canadensis.

Hexandria.—Tamus, Smilax, Rajania, Dioscorea, Elais, Borassus, Mauritia, and a few others, are placed here by Willdenow. Some North American species of Smilax have constantly hermaphrodite flowers along with the barren: the proper place, then, for this genus is the class of Hexandria, unless we retain Polygamia.

Octandria.—Populus, Commiphora, Rhodiola, Margaritaria, and Hermesia. belong to this order. Rhodiola is, perhaps, nothing but a species of Sedum.

Enneandria.—Mercurialis and Hydrocharis, belong to this order.

Decandria.—Carica, the American Gymnocladus, Kiggelaria, Schinus, and Coriaria, are referred to this order.

Dodecandria.—Euclea, Datisca, and Menispermum are placed by Willdenow in this order.

Icosandria.*—Flacourtia and Hedycarya belong to this order.

Polyandria.—This order contains the genus Cliffortia, so named by L., in honour of George Clifford, J. U. D. of Amsterdam, one of the early patrons of the Swedish naturalist, and a great encourager of Botany in general. Here, also, the Palms, Cycas, and Zamia, are placed by Willdenow and Persoon.

Monadelphia.—To this order belong Juniperus, Taxus, Ephedra, Cissampelos, Adelia, Myristica, Latania.

Syngenesia.—*Ruscus* and *Kanthe* (the latter a genus of Schreber) belong to this order.

Gynandria.—To this order is referred the genus Clutia, or more properly Cluytia, which Smith seems to think belongs to the order Pentandria.

This, as well as the order of the same name in the preceding class, is absurdly named. The objections which have been urged against that order will apply with equal force, to the order in the class Dioecia. A Gynandrous plant cannot, in rigid propriety, belong to the class Dioecia. Dr. Smith retains but eight orders in this class: viz. 1. Monandria, 2. Diandria, 3. Triandria, 4. Tetrandria, 5. Pentandria, 6. Hexandria, 7. Polyandria, 8. Monadelphia. Persoon, besides the first six, has the following orders in Dioecia, viz. Octandria, Enneandria, Decandria, Dodecandria, Icosandria, Polyandria, Monadelphia and Gynandria: thus in fact, retaining all the orders which I have mentioned in page 280, with the exception of Syngenesia, which he, Willdenow and others have abolished. The class Dioecia has been abolished by Thunberg, whose arrangement, with respect to the suppression of this class Monoecia, Gynandria and Polygamia, has been

* L. has not an order of this name in the class Dioecia. The order was created for the reception of the genus Flacourtia of L'Heritier, and that of Hedycarya of Scereber.—Smith tell us, he finds no genera truly icosandrous in this class.

implicitly adopted by Gmelin*, by Withering†, and many other writers.

Character.—The genera of the class Dioecia are referred by L., to very different natural orders. Salix, Populus, and Myrica, belong to the Linnean order Amentaceæ, and to Jussieu's order of the same name. Juniperus, Taxus, and Ephedra, are of the Linnean order Coniferæ. The Swedish naturalist refers the wonderful Vallisneria and Hydrocharis to his first order, Palmæ. Mr. de Jussieu refers these two genera, together with Stratiotes, Nymphæa, Nelumbium, Trapa, Proserpinaca, and Pistia, to his order *Hydrocharides*. Smilax, Tamus, Dioscorea, Rajania, Menispermum, Cissampelos, and Ruscus, together with Aristolochia and Cytinus of the class Gynandria, and a number of fine Hexandrous plants, belong to the order Sarmentaceæ, which I have already particularly noticed. Mr. de Jussieu's order Asparagi embraces several of these genera. Carica, Cliffortia, together with Hura, Acalypha, Dalechampia, Plukenetia, Croton, Ricinus, Jatropha Sterculea, Hippomane, and others of the last class, belong to the Linnean order of Tricoccæ. I can merely hint at the medical properties of the plants of this class. The barks of different species of Salix and Populus have been found good substitutes for the Peruvian bark. Candleberry-Myrtle (Myrica) and Missletoe (Viscum) have, likewise, been used as tonic medicines. Two American species of Zanthoxylum, viz. Z. fraxinifolium of Marshall‡ and Z. Clava Herculis, are known in the United States by the names of Prickley-ash, and Toothach-tree. The barks, and the capsules of these shrubs have a most pungent taste, and when taken into the mouth act powerfully by promoting a discharge of saliva. These vegetables are well entitled to the attention of physicians. The Common Hop (Humulus Lupulus) is an article of much importance in the manufactory of brewing, and is, perhaps, the best vegetable, hitherto discovered, for preserving malt-liquors. Various other vegetables have been used with the same intention; such as some of the Gentians, and Menyanthes trifoliata, or Bog-bean, formerly mentioned. The Sweet-Fern (Comptonia, asplenifolia,) of the class Monoecia, has likewise been used, in some parts of the United States, where it grows in great abundance. The Hop is one of the more heating tonic bitters. I think its narcotic power is, upon many occasions, very evident. I am inclined to think, that there is some foundation for the opinion of those physicians who assert that the Hop favours the formation of calculi. But the experience of Cyprianus is opposed to this idea. The Common-Hemp (Cannabis sativa) is also endued with a narcotic power. The seed of the Cocculus indicus (Menispermum Cocculus) intoxicate fish. I am unacquainted with the properties of the North American species of this

* See his edition of the Systema Naturae, &c. Tom. ii. Lipsae; 1791.
† A systematic Arrangement of British Plants, &c. London: 1801.
‡ See his Arbustum Americanum: the American Grove, &c. page 167.

genus, viz, M. canadense, and M. virginicum. Cissampelos Pareira, called by the Portuguese of South America, Pareira Brava, is reputed a valuable lithontriptic medicine. Adelia Ricinella is used in the West-Indies, where it is called Ram-Goat, as an emmenagogue. I have myself employed it with this intention. It is the bark that is used; and this is, certainly, a medicine of powers. The Sarsaparilla of the shops (an article of no great value) is the root of Smilax Sarsaparilla. This grows indigenous within the limits of the United States. A species of Aralia (Aralia nudicaulis of L.,) is also called Sarsaparilla, and is sometimes found in the shops, where it is sold for the genuine kind. The berries of the Common-Juniper (Juniperus communis) are used in different diseases. The berries of the Red-Cedar (Juniperus virginiana) of the United-States, are but little inferior to them in powers.

Several of the vegetables of the class Dioecia furnish us with most interesting arguments in support of the doctrine of the sexes of plants. I may mention the following, viz. Vallisneria spiralis, Cannabis sativa, Rhodiola rosea, Datisca cannabina, and Clutia pulchella. As the male and female flowers of these plants are situated upon different individuals of the same species, it must be evident, that if there be a just foundation for the doctrine of the sexes of plants, as delivered by L. his pupils, and followers, the female individuals of the Dioecious plants will not ripen their seeds, when completely prevented from receiving any of the male influence. Accordingly, we find that such female individuals prove abortive. Innumerable facts seem to establish this truth, which, as yet, has been but little affected by the experiments of Alston, and other writers. The experiments of the Abbe Spallanzani, with the Hemp, the Hop, and several of the Cucurbitaceous plants of the class Monoecia, are of more consequence. I am far, however from thinking, that they essentially invalidate the doctrine of the sexualists, who assert the necessity of an intercourse between the stamens and the pistil, or male and female organs, for the great purpose of giving fertility to the seed. The sexual doctrine seems to rest upon a very substantial basis. It will require a great body of facts and experiments to prove, that the stamens, or a powder (the pollen) secreted upon the surface of the anthers is not essentially necessary to render the pre-existing seed fertile. Although in the plants of the two classes Monoecia and Dioecia, the stamens and the pistils, or male and female organs, are situated within different covers, and often at a considerable distance from each other, it has, nevertheless, been observed, that very generally the two sexes appear nearly at the same time. This fact, as it regards the Indian-corn, is known to every cultivator of this vegetable. The circumstance cannot but be deemed of considerable weight in support of the sexual doctrine. In the amentaceous plants of the class Monoecia and Dioecia, the stamens of the male aments do, indeed, almost universally* make their appearance before the female

* The late ingenions Mr. L'Heritier has said, it is the case in every instance.

organs. But the former upon the appearance of the latter, are always in a fit condition to perform the generative act. I think, the Sweet-Fern (Comptonia asplenifolia of Aiton) affords an exception to the general rule which I have mentioned. In this shrub, the female organs make their appearance a good while before the males. There is another circumstance in respect to the plants of the classes Monoecia and Dioecia, which has often been adduced as an argument in favour of the doctrine, that an intercourse between the stamens and the pistils is necessary to give fertility to the seed. As in these plants, the male and female organs are situated at a distance from each other, so that the facility of an intercommunication between them is certainly less than in the hermaphrodite flowers, where the sexual organs are situated within the same cover (calyx or corolla,) Nature has wisely ordered it, that in these particular plants the sexual organs shall, in general, make their appearance before the full evolution of the leaves, so that the fecundation is not hindered by the intervention of the leaves. This is known to be the case in the Mulberry, the Misletoe, the Alder, the Birch, the Hornbean, the Beech, the Oak, the Hazel, the Walnut, the Willow, the Sea-Buckthorn (Hippophae,) the Dutch-Myrtle (Myrica,) the Poplar, the Ash, and the Dogs-mercury (Mercurialis.) How impressively does this fact mark the hand of an intelligent being, in the construction and in the government of the world? And yet, there have been atheistical cultivators of Botany, as well as of Astronomy! Many of the genera of the class Dioecia are natives of the United States. I mention the following, viz. Vallisneria, Salix, Empetrum, Hippophae, Viscum, Myrica, Humulus, Acnida, Zanthoxylum, Smilax, Dioscorea, Populus, Menispermum, Mercurialis? Hydrocharis? Juniperus, and Taxus. For an illustration of the class Dioecia, see Plate XXXIX, Figures 1 and 2.

CLASS XXIII.--POLYGAMIA.

Polygamia* is the name of the twenty-third class. Dr. Darwin has named it the class of Polygamies. It embraces those plants, the different individuals of which bear hermaphrodite flowers, and, likewise, male or female flowers, or both. This is a very peculiar class. In order that a plant should belong to it, it is absolutely necessary, that some of its flowers should be hermaphrodite. But beside these, there are male or female flowers, or both. These circumstances readily distinguish the class Polygamia from the two preceding classes to which it is allied, for in neither of these classes do we find hermaphrodite flowers. The following are the various modes of which the polygamy of the plants of this class, is susceptible.

A. Hermaphrodite and male flowers, situated upon the same indi-

* From Πολυς, many, and γαμος, marriage.

vidual, as in White-Hellebore (Veratrum,) Nettle-tree (Celtis,) and several others. This mode of polygamy is, likewise observable in several of the Umbelliferous plants, of which I have formerly given an account, particularly in Carrot (Daucus,) Sanicle (Sanicula,) Coriander (Coriandrun sativum,) and others. In rigid propriety, therefore, these plants, instead of having been placed in the class Pentandria, ought to be referred to the class Polygamia. But L. was sensible, that the order of Umbelliferæ is a natural order, and that to have separated these Polygamous species from the others, would have been striking "a fatal blow at the very root of his system." (Dr. Milne.)

B. Hermaphrodite and male flowers, on distinct plants, or individuals, as in Ginseng (Panax quinquefolium,) Tupelo, tree, or Sour-Gum (Nyssa,) and others. C. Hermaphrodite, and female flowers on the same individual, as in Pellitory (Parietaria,) and Orach (Atriplex.) D. Hermaphrodite, and female flowers on different plants as in many species of Fraxinus, or Ash-tree. E. Androgynous and male flowers upon distinct plants, as in Arctopus, and in Amber-tree (Anthospermum.) These have male and female flowers upon one individual, and male flowers only on the other. F. Androgynous, male, and female flowers upon three distinct individuals, as in Carob-tree (Ceratonia,) and Fig-tree (Ficus.) These have no hermaphrodite flowers. G. Hermaphrodite, male and female flowers, upon two distint plants, as in Honey-Locust (Gleditsia triacanthos.) Here we find the male and hermaphrodite flowers placed upon one plant, and the female flowers upon the other.

H. Male hermaphrodites and female hermaphrodites on the same plant: that is, flowers which, although they contain the parts proper to each sex, have, however, one of the parts reciprocally abortive; viz. in some, the stamens, or male organs; in others, the pistil, or female organ. In the former case, they are denominated female hermaphrodites; in the latter, male and hermaphrodites, according as either of the two sexes predominate. We have an instance of this singular mode of polygamy, if, indeed, it deserves that name, in the flowers of the Plantain, or Banana-tree. (Musa.) The class of Polygamia is subdivided into three orders, viz. Monoecia, Dioecia, and Trioecia.

Monecia.—This order contains those genera, the flowers of which have stamens, without pistils; pistils without stamens; and others with both stamens and pistils, all on one plant or root. The following are the principal genera of the order, viz. Musa, Holcus, Cenchrus, Ischæmum, Manisuris, Aegilops, Spinifex, Andropogon, Apluda, Valantia, Ophioxylon, Celtis, Veratrum, Fusanus, Acer, Gouania, Solandra, Mimosa, Brabeium, Terminalia, Clusia, Hermas, Parietaria, and Atriplex.

Dioecia.—In this order, the different flowers are situated upon two different individuals of the same species. The following are the principal genera of the order: viz. Panax, Diospyros, Chrysitrix, Stilbe, Nyssa, Fraxinus, Anthospermum, Arctopus, Gleditsia, and Pisonia.

Trioecia.*—This order contains the genera Ceratonia, and Ficus. The latter is a very extensive genus.

Character.—The class Polygamia has been abolished by Thunberg, Gmelin, Smith, and other writers. I cannot doubt of the propriety of suppressing this class of the sexual method, though I am far from being convinced, that the destruction of the three preceding classes, Dioecia, Monoecia, and Gynandria, has been any improvement upon the original scheme of L. Polygamia is, certainly "a bad and unnatural class, variable and obscure."† L. himself appears to have been fully sensible, that objections might be urged against the establishment of this class; for he has offered as an apology for it, that he was desirous, that his system should embrace all the known modes of sexual intercommunication. And this, it is evident, could not have been done, had the class Polygamia been omitted. However, although I am not inclined to approve of the whole of the alterations in the sexual system, which have been made by Thunberg, and adopted by other writers, I think the class now under consideration ought to be abolished. I have on a former occasion, given the same sentiments respecting the class Dodecandria. With respect to the class Polygamia, it is a fact that a very considerable number of the plants which L. has thrown into his classes of true hermaphrodite flowers, do occasionally bear, beside the hermaphrodite flowers, flowers merely with males, (stamens,) or with females (pistils.) If therefore, we were inclined to pursue the Linnean rule with obedient footsteps, I suspect that there is hardly one very extensive genus in the sexual system, some one species of which, would not fall into the class of Polygamia; for it is a fact that the same species of plants does in a remarkable manner, vary its sexual organs in different climates; nay the same individual has been observed to do this, in different years, even in the same climate. "The great fertility and exuberance of the soil in some of the tropical isles, is perhaps one of the reasons (says a learned writer) why such a number of their plants belong to the Linnean classes of Monoecia, Dioecia, and Polygamia, and it is remarkable that plants which botanists have observed to be hermaphrodites in America, here bear their male and female flowers on two distinct shrubs, and this may confirm the opinion, that most dioecous plants, are somewhere or other also found in the hermaphrodite state; which, if it were general, would entirely set aside that class," &c.‡ In addition to these observations, I may observe, that I have long been persuaded, that the vegetables of the United States, particularly, perhaps, those of the Southern States, are much more variable in regard to their sexual organs, than are the same species, or given number of species, in Europe. This I shall particularly show, in an appropriate work. Upon the whole, I am of opinion, that the class of Polygamia ought

* From τρεις, three and οικος, a house. † Dr. J. E. Smith.

‡ Observations made during a voyage round the world, &c. &c. p. 179 and 180. By John Reinold Forster, L. L. D. &c. London: 1778. 4to.

to be suppressed, and the plants which it embraces referred to the other classes of the system.

But, although this is my opinion, I will not omit to furnish the student with the sentiments of a veteran in Botanical science, on the subject. "Some modern reformers (says Dr. Martyn) have entirely discarded this class, and thus have simplified the Linnean arrangement, and rendered it more easy to beginners; but they have, at the same time, wholly mutilated it, considered as a sexual System. We may go on reforming till we reduce it to the simplicity of Rivinus's system; when it will acquire great facility, and at the same time become good for nothing."*

The class Polygamia, as we have seen, contains a considerable number of genera: Of these the following belong to the order Gramina, or Grasses, viz. Holcus, Cenchrus, Ischæmum, Manisuris, Aegilops, Spinifex, Andropogon, and Apluda. Musa belongs to the noble order of Scitamineæ; Mimosa, Gleditsia, and Ceratonia, to the order Lomentaceæ: Fraxinus to Sepiariæ; Diospyros to Bicornes; Celtis, Parietaria, and Ficus, together with Cecropia, Cannabis, Humulus, and Acnida, of the class Dioecia, are arranged in the order *Scabridæ.*† Panax together with Zanthoxylum, Aralia, Hedera, Vitis, and Cissus, of former classes, are referred to the forty-sixth Linnean order, called *Hederaceæ.* In the system of Mr. de Jussieu, Panax is referred to an order called *Araliæ.* This is the first order of the twelth class, in the method of the French botanist. It contains, beside Aralia (which gives name to the order) and Panax, the genera Gastonia, Polyscias, and Cussonia. The class of Polygamia embraces a number of useful and curious plants. To the first head may be referred those which are esculent, or medicinal. The fruit of the Plantain and Banana (species of Musa) and that of the Fig (Ficus) are some of the finest fruits with which we are acquainted. Different species of Diospyros also furnish us with good fruits. That of the common American Persimmon (Diospyros virginiana) is a very desirable fruit when it has been affected by the frost. Previously to this, it is extremely astringent, and cannot be eaten. From this fruit a good spirit and beer have been made; and the Indians in the southern parts of the United States, make bread of it, mixing with the ripe pulp a portion of the flower of the Mays, or Indian corn. At some future day, the preservation, if not the cultivation of the persimmon will be deemed an object worthy of the attention of the people of the United States. The fruit of the American Nettle-tree (or Celtis occidentalis,) commonly called Sugar-nut, is agreeable eating. This and the persimmon are the favorite food of various species of

* The Language of Botany &c. article Polygamia.

† From *Scaber*, rough, rugged, or bristly; so called because many of the plants of this order have rough leaves. Many of the plants of the order Asperifoliæ formerly mentioned, have, also, rough leaves: but the leaves of several of the Scabridæ are still more remarkable for their roughness.

American birds. Under this head, I must not omit to mention the American Sugar-tree, or Maple (Acer saccharinum,) from the juice of which is prepared an excellent sugar, but little, if at all, inferior to the best sugars obtained from the true sugar-cane Saccharum-officinarum,) of the Indies. The Sugar-Maple spreads through an extensive tract of country in North America, viz. at least from the latitude of 52 to that of 33. Before the Europeans came into America, the natives made sugar from this tree, and also from some species of Juglans, or Hickory. The legumes of the Honey-locust (Gleditsia tracanthos) contain a very agreeable saccharine matter, combined, however, with a good deal of astringency. The class Polygamia does not give to the materia medica, any very indispensible articles, strictly medicinal. Some species of Veratrum, particularly V. Sabadilla, have a place in certain foreign dispensatories. The root of Veratrum luteum, called Devil's-Bit,* is used in the United States as a bitter, tonic medicine. The bark of the Persimmon is entitled to attention;† as are, also, the barks of some species of Fraxinus, or Ash. It is difficult to speak, with confidence of the Ginseng (Panax quinquefolium.) It will, however, hardly be doubted, that its medicinal virtues are greatly overrated by the Chinese. The extensive family of Mimosa, commonly called Sensitive plants, supply us with some useful alimentary and medicinal articles. The Gum Arabic of the shops, is the produce of the Mimosa nilotica, which grows in Arabia, in Egypt and in Senegal. The Mimosa Senegal furnishes us with a gum very similar to this. The extract of Catechu, commonly called *Terra Japonica*, is the produce of the Mimosa Cate. There are some reasons to believe, that some other valuable medicinal articles are given to us by species of this genus. In a physiological point of view, different species of Mimosa are some of the most interesting vegetables that are known to us. There belongs to these plants, in an eminent degree, that principle of living organized bodies which is called irritability; a property which the great Haller and other learned men‡ have restricted to the animal fibre, but which is now known to exist in many vegetables also.

Several of the genera of the class Polygamia are natives of the United States. The following are the principal of them: Andropogon, Celtis, Veratrum, Acer, Mimosa, Panax, Diospyros, Nyssa, Fraxinus, and Gleditsia. The American species of Acer have not been investigated with sufficient attention. A complete history of the Sugar-Maple is still much desiderated. Dr. Rush's paper on this subject, may however, be consulted with advantage.§ For an illustration of the class Polygamia, See Plate XXIX.

* See the explanation of Plate II.

† See Collections for an Essay, &c. page 11.

‡ Caubius, C. F. Wolf, Necker, &c. &c.

§ See Transactions of the American Philosophical Society, Vol III. No. IX.

CLASS XXIV.—CRYPTOGAMIA.

To the twenty fourth and last class of the sexual system, L. has given the name of Cryptogamia.* This is Dr. Darwin's class of Clandestine Marriages. It contains a vast assemblage of vegetables in which the parts of the fructification are, either from their minuteness, or from their particular situation, entirely concealed, or imperfectly visible; so that the plants are, with difficulty, referred to any of the preceding classes. L. has subdivided this class into four distinct orders, viz. Filices, Musci, Algæ, and Fungi.

Filices.—This is an extensive and beautiful family of vegetables. They are defined to be plants, which bear their flower and their fruit on the back of the leaf or stalk, which, in this class of plants, are the same. Many of the Ferns, however, bear their fructification in a spike.

The following are the genera which L. has referred to this order; Equisetum, Cycas, Zamia, Onoclea, Ophioglossum, Osmunda, Acrostichum, Polypodium, Hermionitis, Asplenium, Blechnum, Lonchitis, Pteris, Adianthum, Trichomanes, Marsilea, Pilularia, and Isoetes.—Cycas and Zamia are true palms.

Musci.—*Lycopodium*, Porella, Sphagnum, Phascum, Splachnum, Polytrichum, Mnium, Bryum, Bartramia, Hypnum, Fontinalis, and Buxbaumia, belong to this order.

Algae.—To this order are referred the genera Marchantia, Jungermannia, Targionia, Anthoceros, Blasia, Riccia, Lichen, Byssus, Tremella, Ulva, Fucus, and Conferva.

Fungi.—The genera Agaricus, Boletus, Hydnum, Phallus, Clathrus, Helvella, Peziza, Clavaria, Lycoperdon, and Mucor, are referred to this order.

The learned Professor Schreber has divided L's. order of Filices into two distinct orders. The genera Marsilea, Pilularia, and Isoetes, together with some of the *Filices spicatæ*, or Ferns with fructifications in spikes, and also the genus Lycopodium, which L. refers to the Mosses, he places under an order called *Miscellaneæ*. Dr. Withering and some other writers have adopted this alteration, which however, to use the words of an eminent botanist, "can be tolerated only till we know the subject better."

Since the time of L. the plants of the class Cryptogamia have been investigated, with great zeal and labour, by a number of the botanists of Europe, among whom I may particularly mention the learned Dr. Hedwig, of Leipsig, Mr. Dixon, Dr. Smith, Mr. Hoffmann, Mr. Persoon, Mr. Tode, Mr. Bolton, Mr. Bulliard, Professor Batsch, Mr. de Beauvois, and many others. Indeed, the plants of this class have

* From κρυπτω, to hide, and γαμος, a marriage. The angry Mr. De Necker has proposed to name this class Agamia, because he is of opinion, that the Cryptogamic plants are entirely destitute of stamens and of pistils.

been investigated with a species of zeal which has led a late botanist* to denominate the ardent rage for inquiries after them, Cryptomania. To the patience and learning of the botanists whom I have mentioned, we are indebted for most important information, but to none of them perhaps, so much as to the late Dr. Hedwig, whose discoveries with respect to the Cryptogamic plants may be said to have formed an important era in the science of Botany.

It has long been a disputed point, whether the plants of the class Cryptogamia are produced from seeds, and whether they have flowers as have all the other plants with which we are acquainted. The learned author of *Hudibras* notices this dispute, as it respects the Ferns. Or, rather, he has considered the Ferns as destitute of seeds, and as arising by a spontaneous generation.

With respect to the Mosses, many botanists have positively asserted that these plants which are spread so extensively over the earth, are entirely destitute of flowers, or sexual organs. Among the number of these writers, I may mention the respectable names of Tournefort, Adanson and Necker. The last of these authors is extremely hostile to the notion that the Mosses have sexual organs. "Whatever (says he) has been or can in future be said of the sexes and copulation of the Mosses, we are determined to consider as a fiction and a dream." L. and Dillenius (the celebrated Professor of Botany at Oxford) concluded, both from observation and analogy, that the Mosses were, like other plants, furnished with flowers and with seed. These illustrious investigators of plants were even of opinion, that they had discovered both flowers and seeds. But they were mistaken. Micheli, a patient Italian botanist appears to have been the first person who observed the real stamens and pistils in the Mosses. He published this important discovery in the year 1729. But his observations were neglected and indeed hardly credited until the learned Hedwig, of Leipsig, published his great work on Mosses, which I have already noticed on a former occasion. In this work, Hedwig demonstrated in a very satisfactory manner, the parts of fructification in a large number of Mosses, and even endeavored to prove, that their seeds like those of other vegetables are furnished with their proper cotyledons. The opinion of the German botanist respecting the existence of seeds in this tribe of plants is now, I believe, universally admitted, notwithstanding the efforts of Necker and other botanists, to disprove the notion.† Hedwig raised the Mosses from seeds. Hedwig has also shown that many of the Mosses are true Monoecious and Dioecious plants. He has detected the sexual organs in the Ferns, in the Algous plants, and even in the

* Mr. de Necker. "*Cryptomania*, immoderata cupiditas, qua ab excogitato ficto, ad veritatem occultam, traducere conantur, pertinaces sexualismi universi fautores, ut sexualis systematis menda, scientiæ cultoribus, credulisque botanicis perpetuo ignota fit." Corollarium, &c. p. 20.

† See the explanation of Plate XXX.

Fungi. He has, thus, to use his own words, "vindicated the sexual propagation against all who doubt or preposterously deny it."

Character.—The vegetables of the class Cryptogamia are referred by L. and other botanists, to several distinct families. Thus the Filices constitute the fifty-fifth of the Swedish botanists natural orders: the Musci, his fifty-sixth, the Algæ his fifty-seventh, and the Fungi his fifty-eighth natural order. In the method of Mr. De Jussieu, the (*les Champignous*) constitute the first order of the first class: the Fungi Algæ (*les Algues*) the second order: the Musci (*les Mousses*) the fourth; and the Filices (*les Fougeres*) the fifth order. The learned French writer has, also, an order, his third order, which he calls Hepaticæ (*les Hepatiques.*) This embraces the following genera, viz. Riccia, Blasia, Anthoceros, Targionia, Jungermannia, and Marchantia, which L. places among the Algæ. The Ferns are one of the seven families, or natural tribes, into which the whole vegetable kingdom is divided by L.* They constitute the sixteenth class in the method of Tournefort, and the fourth by the name of *Capillares* in the method of Mr. Ray. Dr. Haller denominates these plants, *Epiphyllosphermæ*, or plants which bear their seeds upon the back of the leaf.† By other writers, they are denominated *Acaules,* because they are destitute of a proper stem. The Ferns are very abundantly diffused over the earth. They are particularly abundant in some countries; such as the West-Indies, and also in North America, where they constitute a beautiful covering upon the summits of many of our mountains. The roots of many of these vegetables creep and extend themselves, on an horizontal direction under the earth. The stem is not to be distinguished from the common footstalk, or middle rib of the leaves, which has given occasion among some writers, to name them Acaules, or plants destitute of stems. In the Spiked Ferns, however, such as Ophioglossum, Osmunda, and others, the middle rib overtops the extremity of the leaf, or frond, and forms a stem upon which the flowers are supported. The leaves proceed either singly or in greater numbers, from the extremities of the branches of the main root. In the greater number of the genera, they are winged, or hand-shaped. In most of the known Ferns, the flowers are fastened to the back of the leaves. These are the true Dorsiferous Ferns. In others, however, the fructification is in spikes. The sexual organs of these plants, as I have already observed, have been most carefully investigated by Hedwig, who has even been able to refer some of the plants from the number of their stamens and germs, to preceding classes. Thus he refers the Horse-tail or Scour-grass (Equisetum) to Tetrandria Monogynia. The Ferns appear to have been among the most ancient vegetable inhabitants of our earth. They are frequently found impressed in stones of different kinds, particularly shistus, or slate, and in nodules

* Philosophia Botanica, &c. p. 37. § 78.

† Historia Stirpium Indigenarum Helvetiæ inchoata. Tom. III.

of iron-stone in almost every part of the earth. Such impressions are very abundant in the United States. It is a curious circumstance that we frequently find these impressions in countries where the species are no longer natives. Thus most of the Filices that are found in the impressed state in Britain, seem to be the American plants.* Impressions of the leaves of the Flowering Fern of Royal Moonwort (Osmunda regalis) are frequent in the nodules of iron-stone found in some parts of England. A respectable writer observes, that this is the only species of an indigenous British vegetable that he has ever seen in a fossil state. But even this species of Osmunda is, also a native of various parts of North America. I believe it may be shown, that other native British Ferns are sometimes found in the impressed state in the slate, and in the iron-ores of the country. But the Filices do unquestionably furnish us with one among the many other facts which might be adduced to prove, that the globe which we inhabit has undergone great revolutions. The period of the existence of the Ferns of America in Britain and in many of the Asiatic vegetables in the same and other parts of Europe, was, in all probability, anterior to the date of any of those revolutions of which the memory is preserved in the *written* monuments of mankind. The Mosses are the third of the seven families into which L. has divided the vegetable kingdom. They constitute the third class in the method of Ray. In the system of Tournefort, they constitute a single genus, or family by the name of *Muscus*, in the first section of the seventeenth class, which contains beside the Mosses, the Mushrooms, and some of the Algous plants, or Sea-wrack. To the whole of this class, the great French botanist has given the name *Aspermæ*, or plants without seeds: for in the time of Tournefort, the seeds of those plants had not been discovered. But we have seen that the seeds of the Mosses and other plants belonging to the class of Cryptogamia, have been detected by the vigilant researches of Hedwig, Gærtner, and other writers. In the form and disposition of their leaves, in the manner of their growth, and in other circumstances, the Mosses considerably resemble the Pines, the Firs, and other Coniferous Evergreens, which have already been mentioned. These plants frequently creep and extend themselves like a carpet upon the ground, upon the trunks and branches of trees, and shrubs, and upon various species of stones, being commonly collected into bunches or tufts. Some of the smallest plants with which we are acquainted belong to the Mosses. Few of them attain to the height of a foot, whereas among the Ferns, we have instances of species that are even arborescent. Very few of the Mosses are annual plants: the greater number of them are perennial and evergreen. Their growth is very slow, but they are extremely retentive of the principle of life: or, in other words, they live for a very great length of time. After having been preserved dry for a great number of years, even for a century or

* Dr. Withering.

more, they may be made to resume their primitive verdure simply by moistening them. I have already hinted at this circumstanee in a former part of the work. The Mosses inhabit the hottest and the coldest climates They delight, however, in a cool and moist situation, and a north exposure, where they are screened from the sun. Many of them delight to grow upon the summits of the highest mountains where vegetation can take place. Others of them, however, affect more humble situations, such as the margins of rivers. L. has distinguished the genera of the Mosses principally from the presence or the absence of the calyptre, which (as we have already seen) he considers as the calyx of this family of plants. For some notices concerning the seeds of the Ferns and Mosses, and also those of the Algæ and Fungi, I must refer the reader to the first part of this work.

I have already made mention of the Hepaticæ: *les Hepatiques* of Jussieu. Of these I am now to take some farther notice, though no order of this name occurs in the system of L. This writer it has already been hinted, comprehends the whole of the Hepaticæ under his order of algæ. With the algæ, however, they have much less of a natural affinity than with the plants of the preceding order, or mosses. The Hepaticæ, or as they are called by the English writers, Liverworts,* have, for the most part, their herbage of a frondose nature: that is, the fruetification arises from what is at once the leaf and the stem. "This character, however, as Dr. Smith observes, proves less absolute than one founded on their capsules."† The capsule of the Liverworts is very different from that of the mosses, being totally destitute of the opereulum, or lid,‡ It must not be concealed, however, that we observe an affinity between these two families in regard to that part or organ which we have ealled the calyptra, or calyx of the mosses: but which Smith considers as a kind of eorolla. This, whatever we may think proper to call it, is in some of the genera of Hepaticæ like that of the mosses, though it, for the most part, bursts at the top. The barren or infertile flowers, as they are called, of the Hepaticæ plainly show how much this family of plants differs from that of the mosses;. and, of eourse, how improperly the two series have been confounded together. In the mosses we find the organs called stamens: but the barren flowers of Liverworts are either obscurely defined, powdery heads, or of some other conformation, still, however, very, unlike "organized stamens." The powdery heads may be seen in the genus Jungermannia,§ which is truly one of the Hepaticæ. In Marchantia, the structure is different, and the parts I am speaking of "are imbedded in a disk like the seeds of Lichens, in a manner so eontrary to all analogy, that botanists ean scarcely agree which are the barren and which the fertile flowers of this genus."

* Withering, &c. † An Introduction &c. p. 293

‡ See explanation of Plate XXX. Fig. 8. A. B.—See, also, Plate XXXI.

§ See Hedwig's Theoria, tab. 16.

Algæ.—This is a vast and interesting order of plants. By the English, many of them are called Flags, or Sea-wreck. Their herbage is also frondose: sometimes it is little else than a membranous crust, as in many of the Lichens, formerly alluded to, which cling to the hardest stones, and form a beautiful plating upon whins, sand-stones, &c. Some of them have a leathery, and many of them a gelatinous or mucilaginous texture. Lichen velleus is an example of the first, and Tremella of the last mentioned, texture. This last often *appears* to be nothing else than a mere mass of inorganic jelly: but its organization may be discovered; and Adanson has even shown, that it is sometimes irritable. That it has many of the habitudes of animals, has already been observed. Fontana, indeed, considered it as a kind of intermediate link between the vegetable and animal kingdoms. The physiology of the various species of Tremella is well worthy of much attention: and a patient inquiry, carried on for a considerable time, concerning the properties of these *pseudo-plants*, could hardly fail to conduct the labourer to most important results in regard to the nature and the laws of life. The barren flowers of the Algæ have not yet been satisfactorily investigated. Nor, indeed, do I think it certain, or at all probable, that real flowers belong to all of them. The contrary is much more probable. *Certainly* flowers, in the true and common acceptation of this term, do not belong to all plants. The seeds, or more properly Sporules (sporae) as the indefatigable Acharius calls them, of many of these plants, are sometimes imbedded in the frond itself, and sometimes in a peculiar receptacle for the purpose. In this section of Algæ, we find the vast natural order of plants (for an order or family it unquestionably is,) which L. for want of a better knowledge compressed into one genus, which he has called Lichen. The fructification of these Lichens, as we call them, has been examined. It consists in general of a receptacle,—or as Acharinus is pleased to call it, *apothecium*,—which is sometimes flat, sometimes convex, and sometimes concave. In this receptacle, or disk, the reputed seed are placed.* In others, of the Algæ, the reproductive parts are lodged in "powdery warts," or in receptacles of a fibrous structure. As to the barren flowers, they are supposed to be nearly similar to those of many species of Jungermannia: that is of a powdery texture. These *Lichenes* have, since the death of L. solicted much of the attention of botanists: especially of some learned Germans and Swedes. Here the merits of Dr. Hoffmann, formerly of Goettingen, and of Dr. Acharius, of Stockholm, are peculiarly great. The last mentioned author in two classical works,† which are worthy of the country that gave birth to L. has divided the family of Lichens into various genera, founded entirely upon the receptacle *(apothecium)* of the sporules. It has been regretted however by one who is fully

* See Plate XXX. fig. 13. and fig. 14.

† Lichenographiae Sueciae Prodromus. Lincopiæ: 1798, and Methodus Lichenum, &c. Stockholmiæ: 1803.

sensible of the great merits of Acharius, "that he has been somewhat too prodigal of new terms." With me I confess, this is no objection to the work of the Swedish writer. On the contrary, I think it will often be advisable, in examinations of natural families of plants considerably different from each other, to bestow upon the parts and organs which are somewhat similar to each other, *new* appellations. I have no objection, therefore, to Acharius's term *thallus*, instead of *frons:* or to his *apothecium*, for *receptaculum;*—and I must prefer his term *sporæ* or perhaps *propagines* to that of *semina*, or seeds.*

As to the aquatic or submersed Algæ, which abound both in fresh and in salt water, they seem to constitute a tribe of cryptogamous plants, wholly distinct from those of which I have been speaking. The principal genera of this family are Conferva, Rivularia, Vaucheria, Ulva and Fucus. The second and the third of these genera have been formed by Dr. Roth: the others are genera named or retained by L. These plants are supposed by some able botanists, to be propagated by seed. But that the reproductive parts are true seed, may readily admit of a doubt; and until their structure and nature be better ascertained, it may be well to consider them as mere *propagines*, *gongyli*,† gemmaceous granules *(granula gemmacea*, Ach.*)* &c. In Ulva these propagines are dispersed under the cuticle, through various parts of the membranous or gelatinous substance of the frond. In Fucus, they are collected in tubercles or swellings (*gongyli*,) which vary both in shape and size.—As to the vast genus of Conferva, the supposed seeds of some of the species are lodged in certain capsules or tubercles: and in others, in joints of the frond. But our knowledge of the *modus propagandi* of these algous, as well as many other cryptogamous plants is extremely limited, and imperfect. The Fuci (*Phycei*) and the Lichens are considered by

* Dr. Smith, the writer alluded to, whose words I have quoted, approves of some of the new terms of Mr. Acharius, such as his *cyphella*, a peculiar sort of pit, or pore, on the under side of the *thallus* of some of the Lichens: his *lirellæ*, the black letter-like receptacles of the genus Opegrapha: and his *tricæ*, the analogous parts, resembling a horse-hair coiled up, in the genus Gyrophora, or Umbilicaria—I take this opportunity of observing, that I also approve of the elegant term *indusium*, by which Swartz and Willdenow designate the thin membrane which covers the fructification of the Ferns. The learned Mr. Gleditsch had named this part the *involucrum;* and Dr. Smith, who has paid much attention to this envelope of the Filices, has not "found reason to contrive any new appellation." But the term involucrum, as it occurs in the writings of L. is, perhaps, already too vague for the purpose of exact science and the employment of the new term *indusium* rather aids than confounds the student in his inquiries. Why, upon his own principles, might not Dr. Smith denominate the *volva*, or wrapper, of the Fungi, *involucrum*, also.

† The Gongylus, or Knot, is defined by Willdenow (*Principles of Botany*, &c. page 61.) to be "a round, hard body, which falls off upon the death of the mother-plant, and becomes a new one. An example of this is observed in the Fuci."

Acharius, as esexual *(plantæ esexuales,)* and acotyledonous plants whose fructification and fecundation are either not manifest or obscure. Of the Lichens, however, this industrious writer says the mode of propagation is two-fold *(propagatio duplex,)* viz. by "*propagula* vesicularia gemmacea, ad superficiem sparsa vel congesta, libera; atque per *Sporas* ab apotheciis propriis receptas, nudas vel Thecis obvolutas."* The greater number of the Algæ which we have called submersed, although they be fixed by their roots to rocks, &c., are supposed to derive the whole or the principal part, of their nourishment by their surface. Many other species have no fixed place of residence, but perform as I have already said, extensive migrations upon the ocean. With respect to these, it is more certain, that their roots are not of primary or at least indispensible, importance in conveying nourishment of whatever kind, to the system of the plants. But it still remains to be ascertained, by direct experiments, how far either of the two assortments of Algæ may be supported, by water and other nutrient matters, *independently of their roots.* By reason of the freedom of their mode of existence, many of the Algæ are among the most widely spread plants with which we are acquainted. Fucus natans, which seems to be the plant that so delighted the eyes of C. Columbus, as he approached the shores of America, is supposed by L. to have a more extensive geographical range than any other plant. Perhaps some of the mosses, Mitchella repens, and a few others, are not much less extensively diffused over the earth. Of the various genera which belong to the order of algous plants, none has been examined with so much attention as the genus Fucus. Concerning this, we have classical and important works of Gmelin,† Esper, Stackhouse, Velley, Woodward, D. Turner, and others But the labours of many years will be requisite to complete our knowledge of these plants. In the meanwhile, though the genius and industry of Mr. Dawson Turner and other British botanists will, unquestionably, remove much of the obscurity which hangs over the characters and especially the physiology, of these plants, I cannot but express a wish, that some of my countrymen, who live less remote from the shores of the Ocean than I do, will lend their hand in this interesting and important labour; always, however, remembering, that with genuine philosophers, it will be more important to throw light upon the structure and functions, and uses of plants, than merely to name and describe them. The *Fungi*, or Fungous Plants, shall, on several accounts claim more of my attention. These are denominated by the English and Americans, Mushrooms, Toadstools, Punk, &c.—By the French, *les Champignons*, and by the scientific Germans, *Pilze.* They constitute a vast family of organized bodies, whose history, notwithstanding all the attention which has been bestowed upon it by Schæffer, Medicus, Bulliard, Sowerby, Persoon, and

* Methodus, &c. Præmonenda, XXV, XXVI, XXVII.
† Historia Fucorum. 1768.

other patient writers, is still very imperfectly understood. These plants are destitute of leaves, and every other kind of true herbage. Their whole aspect is essentially different from that of almost all other plants. They vary in size from some of the minutest plants* with which we are acquainted, and for the investigation of whose grossest structure the glass is requisite, to species a foot or more than this in height. Their substance is said to be "fleshy:" and the fibres of which it is composed, are often at least differently arranged from those of other plants.† They differ in texture, or firmness, from the most delicate watery pulp, to a farinaceous, a leathery, or even a woody texture. Many of the fungi are beings of a very quick growth: they rise up on a sudden before our eyes, and in the term of a few hours, assume an organization as complex as that of many other plants, whose growth is gradual and slow. Some of the species, however, appear to be of a very slow growth, such as the great farinaceous Tuber, called in the United States "Tucka-hoe," "Deer-Turnip," &c. In this respect, the species alluded to, resemble the mosses. Unlike the mosses, however, the greater number of them are short-lived: they are beings of a day, and quickly lose their form and putrefy. Some of the species, however, live for a long time. The age of the Deer-Turnip is, unquestionably, considerable. The colours of the Fungi are extremely various. They are often of a white or milky-white hue; yellow, orange-coloured; violet, blue and of the most beautiful miniate hue. Some of them are quite black, as various species of Clavaria. A few are somewhat greenish. It is remarkable, that the colours of these *cryptogamæ* are much less influenced by the agency of light, than the colours of other plants. It is certain, at least, that fungi of various colours besides white are often found in subterranean situations, such as deep mines, from which the light of the sun has been, for years or centuries totally excluded. I may here observe that both light and pure air seem to be less necessary to the existence of the fungi than to that of other plants. Few of the plants of the preceding classes arrive at perfection without the agency of light. It is this which gives them their brilliant hues; their green in particular, which is so agreeable to us all: it is light too which gives them many of their peculiar and most useful properties. But the colours of the fungi it has already been observed, are in some, perhaps in a great degree independent of light. Nay, the green seems to be foreign to these plants: for we seldom observe the green hue, even in those fungi which have the benefit of the light. Nor does pure air seem to be so necessary to the fungi as it is to many other plants. Many of them not only spring up in the darkest situations, but also in situations where the air is extremely impure.

* Such as the various species of Aceadium, &c., which we find upon the leaves of Rubus occidentalis, Arum triphyllum, and many other plants, in the vicinity of Philadelphia, and elsewhere.

† Scopoli. Deliciæ Florae, &c. Pars i. p. 43.

Our cellars, dunghills, and the deep recesses of the woods are the favourite places of growth of many of the fungi. They suffer from the contact of pure or atmospheric air. The organ of this vast assortment of organized bodies has been a matter of curious speculation among the learned and even among the vulgar, of all ages. Some eminent men have fancied, that the fungi are more nearly allied to the reign of animals, than to that of vegetables. Nor has this opinion been unsupported by some plausable arguments. The quickness with which they decay, the cadaverous-like odour which the greater number of them exhale, while passing to a state of decomposition; the preference which various species of insects show to them, in searching for proper *nidi* in which to deposit their eggs, have all seemed to favour the hypothesis, that the fungi are truly subjects of the animal kingdom. Like animals, too, they furnish, on analysis, a large quantity of ammoniac, or volatile alkali. In this respect, however, they are not alone among the subjects of the vegetable kingdom.—See the class Tetradynamia. Lichtenstein, as I learned by a communication from my late excellent friend and correspondent, Professor Zimmermann, thought he had proved that the fungi are truly animals: he even fancied that he could perceive the motions of the gills of certain species of them. Medicus thought the fungi were formed by a species of crystallization. In favour of this opinion of a very learned man, I might adduce the observations of Bauer, concerning the formation of fungi in the vinegar of Red Roses: and my own observation concerning the formation and growth of a plant of this family, in a solution of the borate of soda, or the common borax. The prevailing notions of the vulgar, that the fungi, of whatever kind, are formed out of the materials of rotten wood, though perhaps not much less philosophical than the opinions of Bauer, Medicus, &c., must not detain us. We must, I think, consider the fungi as subjects of the vegetable kingdom. This has been proved by eminent botanists of our own immediate times, who have even detected the reproductive organs, by whatever name we may choose to call them, of many of these plants. These organs in some of the fungi, are extremely minute; and it has been ascertained that some of them are reproduced by a matter obtained from the washings of them. We are not yet prepared to give a complete or satisfactory arrangement of the fungi. That by the laborious Persoon is allowed to have merit; deserves to be mentioned, and may be adopted, until some future writer, enjoying still greater opportunities, shall give us a still more scientific *methodus* of the objects which we are considering. Persoon gives us two heads of fungi: viz. *Angiocarpi* and *Gymnocarpi*. 1. Angiocarpi. These are such fungi as have their seeds, or reproductive organs, internally situated. 2. Gymnocarpi. In these the reproductive organs are imbedded in a peculiar dilated membrane, denominated, by Persoon, the *hymenium*. The most familiar instances of the hymenium occur in the two great genera of Boletus and Agaricus, which are, perhaps, no where more abundant than in America, and even in the

United States. In the former of these genera, the supposed seeds are lodged in a porous hymenium: in the latter, in the parallel plates called in the language of botanists *lamellæ*, and commonly gills. The structure of these is such as to almost lead us to hazard the hypothesis, that they are the resipiratory organs of the plant. These, too, are the parts, in which Lichtenstein imagined he saw spontaneous, animal-like, movements. Was he mistaken? Mr. Persoon has been praised for his reserve in introducing new terms. His *hymenium* we have already mentioned and explained. By *peridium* he means "the round membranous dry case of the seeds" in some of the fungi belonging to the section of Angiocarpi. By the term *pileus*, or the hat, all writers on botany mean the head of the gymnocarpous fungi, such as common Agaricus campestris, and many others.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. I. The principal figure on this plate may serve to illustrate the XIIIth class, or Polyandria. It is the figure of the Sarracenia purpurea, or Purple Side-Saddle flower. Of this very singular plant, which is a native of various parts of North America, I have already made mention. A. Represents one of the hollow leaves *(folium tubulosum)* cut off at the end. B. The scape *(scapus,)* supporting the flower, C. D. E. F. This is an anterior view of the flower. C. E. Two of the five petals. D. One of the leaves of the superior perianth *(perianthium superius.)* F. The peltate or target-shaped stigma *(stigma peltatum.)* G. One of the leaves of the superior perianth. H. The inferior perianth, which consists of only three leaves *(perianthium inferius, triphyllum,)* whereas the superior perianth is pentaphyllous, or consists of five leaves *(pentaphyllum.)* I. A scape supporting the parts of the flower K. L. M.—K. The receptacle *(receptaculum.)* L. The germ (*germen.*) M. The peltate stigma.

This singular genus of plants, of which several species are now known to the botanists, was named in honour of I. Antonius Sarrasin, a French botanist, and physician of Quebec.

Fig. 2. The American Cranberry, or Vaccinium macrocarpon of Aiton. The leaves are alternate (*folia alterna:*) the corolla is campanulate or bell-shaped (*corolla campanulata,*) and consists of one petal, the segments of which are reflected. The stamens are eight in number; the germ inferior or placed below the corolla (*germen inferum;*) the fruit, a berry (*bacca.*)

This plant and the Sarracenia frequently grow together, in boggy ground.

The plant is represented nearly of its natural size; though we often see specimens considerably larger, and not a few somewhat smaller. The drawing is correct, and will convey a satisfactory idea of the plant, which is, on many accounts, one of the most interesting in North-America. All the leaves of the Sarracenia purpurea are radical (*folia radicalia,*) and hollow, each forming a kind of funnel, or rather bot-

tle, the form of which will be better understood by an inspection of the plate, than by the most studied description. The young leaves are quite closed at the top, and it is only as they advance in size and age, that they become pervious. The inside of the leaf is generally beset with innumerable fine processes, or setæ, the points of which look *downwards:* but these setæ are principally observed about the upper constricted part of each leaf, which may be called its neck, and which is distinctly visible in the two principal leaves, on the right and left of the drawing. The use of these setæ will afterwards be hinted at. The Sarracenia purpurea is never found in *uniformly* dry ground, but always in boggy ground, and sometimes in ponds of water of some depth. In this latter situation, we sometimes find it with its roots hanging loose in the water, entirely unconnected with the ground. Wherever we find the plant, its leaves (the *older* ones) almost constantly present to us two interesting phenomena: They contain a quantity of water,—and this even in the dryest weather, when neither rains nor visible dews have fallen;—and a number of insects, generally small and almost always dead. It is these two circumstances which render the Sarracenia an object of curiosity among botanists, and especially among the physiological botanists. What is the use of this structure of which I have been speaking? Why have the leaves been formed hollow? And why do we so generally find insects in them? I shall not pretend to give satisfactory answers to these questions; but the subject is too curious not to demand the offering of a conjecture.

I formerly imagined, that as the Sarracenia is destined to grow in wet places, which, however, are liable, at times, to become nearly dry, so the hollow leaves, or *ascidia*, are intended to serve as reservoirs (*hydriæ*) of water, that the plant may not suffer from a deficiency of its favourite and most indispensible aliment, in the hotter weather, or when there has been a long-continued draught.* But various circumstances induce me to relinquish this idea: for the younger leaves, to whose growth and health water must be peculiarly necessary, are, as I have already said, impervious, and contain no water: and, again, the plant when it grows in the water,—that is, in situations not liable to become dry,—and where of course it cannot stand in need of the apparatus of reservoirs; I say the ascidia, even in this situation, always contain a portion of water. These circumstances alone would almost induce me to relinquish my former theory; and I may add, that the Sarracenia purpurea is much less frequently found in grounds, even occasionally dry, than I had imagined. I have not yet made the experiment, but the experiment would I think show, that our plant would flourish very well, were we to close the openings of the ascidia, and completely prevent them from receiving any supply of water from external sources. Mr. Catesby seems to have formed to himself an hypothesis of the use of the hollow leaves of the Sarracenia. Speaking of Sarracenia purpurea, he

* This appears to have been the opinion of L.

says, "The hollow of these leaves, as well as of the other kind (Sarracenia flava,) always retain some water; and seem to serve as an asylum or secure retreat for numerous insects, from frogs and other animals, which feed on them."* As the insects which are observed in the hollow leaves, or bottles of these plants, are very generally found dead, we can scarcely call them "secure retreats." Nor are the leaves too small to prevent some of the smaller frogs, should they think proper, from making their way into them. Indeed if I do not mistake the American tree-frog (Hyla americana) is not unfrequently found in these leaves. But the following fact plainly proves, that the insects that have taken up their residence in the *ascidia* are by no means safely protected from the attacks of certain animals. Sarracenia variolaris of Michaux (*Flor. bor. amer. tom.* i. *p.* 310.) is furnished with tubular leaves, like the other species of the genus. The leaves of this species, which is a native of the swamps of Georgia and Carolina, contain great numbers of insects. The fact is not unknown to various species of birds, especially to the Brown Thrush, or French Mocking-Bird (Turdus rufus,) and other birds belonging to this and other genera of the order *passeres*. It is common to see numbers of these birds collecting about the Sarracenia, with no other *known* view than to procure the imprisoned insects. They pick holes in the leaves, and then slit them for some distance, and thus readily obtain their prey. They cannot obtain their prey through the mouths of the ascidia.† This fact is well attested. Nor will it be deemed one of the least interesting in the history of the instincts of the class of birds! Although I have not, hitherto, learned, with any certainty, that birds in like manner frequent and dissect the leaves of other species of Sarracenia, besides Sarracenia variolaris, I have no doubt that all the other species of the genus, are in like manner visited and treated: and when we consider the great capacity of the leaves of Sarracenia flava, S. purpurea, &c., and the multitude of insects which they often contain, we may, with great propriety, call them store-houses of the food of birds.

Future observations, will no doubt, show us, that different species of Nepenthes, the Aquarium sitiens, and other similar plants, are, in like manner, subservient to the nourishment and support of birds. But I do not mean to insinuate, that these various plants were furnished with *hollow* leaves, *merely* to satiate the appetite of birds: and yet I could as soon believe this, as agree with a certain learned botanist, from whom I am often compelled to differ in sentiment, that the nectar of plants is of no other use to them, than in so far as it may tempt insects

* The Natural History of Carolina, Florida, and the Bahamia Islands, &c. Vol. ii. page. 70 tab. 70.

† In like manner bees which cannot procure the honey through the mouths of various tubular corollas, slit the tubes, and thus obtain the honey. This is the case with Azalea nudiflora, A. viscosa, &c.

to assist the impregnation of plants.* The same author seems to fancy, that he has discovered the final cause of this singular construction in the leaves of our Sarracenia. As the subject is certainly very curious, I shall devote some attention to it, reserving however, a more ample investigation for a monagraphia of the genus Sarracenia. After observing, that "L. conceived this plant to be allied in constitution to Nymphæa, and consequently to require a more than ordinary supply of water, which its leaves were calculated to catch, and to retain, so as to enable it to live without being immersed in a river or pond;" and after observing, that "the consideration of some other species renders this hypothesis very doubtful;" Sarracenia flava, and more especially Sarracenia adunca, *Exot. bot.* t. 53, being "so constructed that rain is nearly excluded from the hollow of their leaves, and yet that part retains water, which seems to be secreted by the base of each leaf,"—what then (says the respectable President of the *English* Linnean Society) is the purpose of this unusual contrivance? An observation communicated to me two years ago, in the botanic garden at Liverpool, seems to unravel the mystery. An insect of the Sphex or Ichneumon kind as far as I could learn from description, was seen by one of the gardners to drag several large flies to the Sarracenia adunca, and, with some difficulty, forcing them under the lid or cover of its leaf, to deposit them in the tubular part, which was half filled with water, all the leaves on being examined, were found crammed with dead or drowning flies. The S. purpurea is usually observed to be stored with putrefying insects, whose scent is perceptible as we pass the plant in a garden; for the margin of its leaves is beset with inverted hairs, which, like the wires of a mouse-trap, render it very difficult for any unfortunate fly, that has fallen into the watery tube to crawl out again. Probably the air evolved by these dead flies may be beneficial to vegetation, and, as far as the plant is concerned its curious construction my be designed to entrap them, while the water is designed to tempt as well as to retain them. The Sphex or Ichneumon, an insect of prey, stores them up unquestionably for the food of itself or its progeny, probably depositing its eggs in their carcases, as others of the same tribe lay their eggs in various caterpillars, which they sometimes bury afterwards in the ground. Thus a double purpose is answered; nor is it the least curious circumstance of the whole, that an European insect should find out an American plant in a hot-house in order to fulfil that purpose. "If the above explanation of the Sarracenia be admitted, that of the Nepenthes will not be difficult. Each leaf of this plant terminates in a sort of close-shut tube, like a tankard, holding an ounce or two of water, certainly secreted through the footstalk of the leaf, whose spiral-coated

* The same author says, "There can be no doubt"—! ! no doubt! !—"that the sole use of the honey with respect to the plant, is to tempt insects, who in procuring it fertilize the flowers, by disturbing the dust of the stamens, and even carry that substance from the barren to the fertile blossoms."

vessel are uncommonly large and numerous. The lid of this tube either opens spontaneously, or is easily lifted up by insects and small worms, who are supposed to resort to these leaves in search of a purer beverage than the surrounding swamps afford. Rumphius, who has described and figured the plant, says, "various little worms and insects crawl into the orifice, and die in the tube, except a certain small *squilla*, or shrimp, with a protuberant back, sometimes met with, which lives there."*—I have no doubt that this shrimp feeds on the other insects and worms, and that the same purposes are answered in this instance as in the Sarraceniæ. Probably the leaves of Dionæa muscipula, as well as of the Droserae; *Engl. Bot. t.* 867, 869, catch insects for a similar reason."†

Fig. 2. C. The American Cranberry, or Vaccinium macrocarpon of Aiton: the Oxycoccos palustris of Persoon. The leaves are alternate (*folia alterna*:) the corolla is campanulate, or bell-shaped (*corolla campanulata*,) and consists of one petal the segments of which are reflected. The stamens are generally eight in number, the germ inferior, or placed below the corollo (*germen inferum*:) the fruit, a berry (*bacca*.) This plant and the Sarracenia purpurea frequently grow together in boggy ground. D.

PLATE II.

Fig 1. The bulb (*bulbus s. radix bulbosa*) of the beautiful Atamasco-Lily (Amaryllis Atamasco,) a native of the southern parts of the United States. A. The bulb. B. B. Two offsets or suckers, from the lower end of the bulb. C. The radicle (*radicula*,) which in the opinion of many writers is the only true root portion. Fig. 2. a transverse section of the same bulb, intended to show its tunicated or coated structure. a. a b. b. Two eyes, or places, from which proceed the flowers. c. The radicle. Fig. 3. The root of the Fumaria Cucullaria, commonly called Dutchman's Breeches. A. A. Two bulbs. b. b. Small Succulent scales, protecting the lower parts of the bulbs, each of which is capable of becoming a perfect plant. This figure may be said to represent the grumose root (*radix grumosa.*) Fig. 4. The fusiform root (*radix fusiformis*) of the Wild-Carrot (Daucus Carota.) A. A. The main body of the root, or descending caudex, in the language of L. B. B. Mark the commencement of the ascending caudex or stem. Fig. 5. The stem and root of a species of Orchis. The root may be called a palmated root (*radix palmata.*) A. The principal body of it. B. B. The smaller succulent portions. C. The ascending caudex.

Fig. 6. The Ophrys hyemalis, commonly called, in some parts of the United States, Adam and Eve. A. B. The two principal bulbs constituting what L. calls the *bulbus duplicatus s. testiculatus*. C. C.

* See, also, Pennant's Outlines of the Globe, &c. Vol. i. page 236. plate 9.

† An introduction to Physiological and Systematical Botany. By James Edward Smith, M. D. F. R. S. &c. &c.—Page 195—198. London: 1807.

The smaller more fibrous-like portions of the root. D. The radicle. E. The plicated or folded leaf (*folium plicatum.*) Fig. 7. The root and a portion of the stem of the beautiful Limodorum tuberosum of L. (Cymbidium pulchellum of Swartz,) which grows abundantly in the neighbourhood of Philadelphia. A. A. The radicle. B. C. Two small suckers. Fig. 8. The scaly bulb (*bulbus squamosus*) of the Lilium superbum. A. The radicle. B. The scaly portion. Fig. 9. The root, &c. of the Devil's Bit, or Veratrum luteum of L. (Melanthium dioicum? of Walter.) It is a good example of the premorse root (*radix præmorsa.*) A. The extremity of the root, which appears as if it had been bit off. B. The radicles. C. Portions of the leaves, which are all radical (*foli radicalia,*) in this plant. Fig. 10. The granulated root (*radix granulata*) of the White Saxifrage (Saxifraga granulata.) A. A. Granules of the root attached to the fibres, or radicles. Fig. 11. The horizontal root (*radix horizontalis*) of the May-apple (Podophyllum peltatum.) A. The ascending caudex, or a portion of the stem. B. B. b. b. The main body of the root as it creeps, or spreads, in an horizontal direction, under the ground. C. C. C. Fibres, proceeding from the main root.—See Plate XVIII.

All the plants that are referred to in this plate are natives of the United States with the exception of the White Saxifrage, in Fig. 10. This is a native of many countries in Europe.

PLATE III.

Fig. 1. The root of Tuberous Moschatel (Adoxa Moschatellina. A. A shoot proceeding from the root. B. Continuation of the same. This is a species of Tuberous root. Fig. 2. Creeping Crowfoot (Ranunculus repens.) A. A. The stem. B. B. radicles proceeding from the bosom of the leaves. Fig. 3. Common Pilewort (Ranunculus Ficaria.) A. A. The stem. B. Bulbs in the axils *(axillæ)* of the leaves. Fig. 4. The Common Onion (Allium Cepa.) A. Bulbs in the umbel of flowers.—Fig. 5. A branch of the Cardamine pratensis. A. A. Radicles shooting out from the leaves. Fig. 6. A species of Sheeps Fescue-grass intended to show one of the modes by which plants increase. A. A viviparous shoot proceeding from the flower.—Fig. 7. The strobile (*strobilus*) of the American Larch (Pinus pendula of Aiton. Fig. 8. A view of the inner side of one of the scales which compose the strobile, with the seed attached to it. Fig. 9. A single, detached seed with its wing, or *ala*.

Among the bulb bearing plants of the United States, I may mention a very common plant, growing in marshy situations, and easily procured by the student in the vicinity of Philadelphia, &c., where it flowers in June and July. I mean the Lysimachia bulbifera of Curtis, *Bot. mag. n.* 104, the L. stricta of other writers.* The bulbs, which are

* Viscum (*terrestre*) caule herbaceo tetragono brachiato, foliis lanceolatis.

placed in the axils of the leaves, are attenuated at both ends, and are often near half an inch long. By these *gemmæ viviaces*, the plant is readily propagated. A still more interesting bulbiferous plant, is a beautiful species of Begonia, from China, which I have had, in my green house for some years. The short egg-shaped bulbs are axillary and smooth and shining. Even in the green house, the leaves, stem, and root, perish, but in the winter, and especially in the early spring, the surface of the pot is found covered with the bulbs, which rapidly vegetate even upon the surface of the earth. Bryophyllum calycinum of Salisbury *(Parad. Lond.)* Cotyledon rhizophylla of Roxburgh,) a native of India, vegetates principally by the little bulbs, which are placed in the crenatures of very succulent leaves. These bulbs are not to be discovered by the naked eye, though by laying the leaf upon the earth, the new plant is observed to proceed only from the *crena*. By placing the leaf between blotting paper and keeping it there for some time, the bulbs are disengaged, and are easily seen. The plant is very tender, and must be kept (in Pennsylvania,) during the winter, in a hot-house. But during the summer-season, even in the open air, it vegetates with great rapidity, even upon the most arid gravel-walks.

PLATE IV.

This plate is entirely appropriated to the beautiful American Painted-cup (Bartsia coccinea,) which grows abundantly in Pennsylvania, and many other parts of the United States. A. A. A. A. A. A. The large and crimson coloured bractes (*bracteæ*,) which are much more painted than the corolla, or the calyx. B. B. B. The perianth. C. A perianth. D. d. The corolla. E. A portion of a corolla turned downwards, to show the four stamens and the style. F. The four stamens two of which are longer than the other two. G. The pistil. H. The pericarp, which is a capsule, two locular or celled (*capsula bilocularis*,) and two valved (*bivalvis.*) I. The capsule opened, with the contained seed.

This Plate may serve to illustrate the class of Didynamia, and the order of Angiospermia.

PLATE V.

A. B. C. D. F. Representations of the Common Garden-Bean (Vicia Faba. A. The bean, covered with its husk (*cutis.*) 1. The hilum, scar, or eye. 2. 3. The umbilical cord (*funis umbilicalis*) by which the bean was attached to the scar, and to the legume, or pod. 4. The

Linn. Sp. pl. ii. *p.* 1452. L. who had no opportunity of seeing the fructification of this common American plant, has thrown out a suspicion that it might be a species of Loranthus!

small foramen or hole, through which a part, at least, of the fluid seems to enter the bean. B. The bean deprived of its husk. 1. The radicle. C. One half of the bean, or a single cotyledon. 1. The husk. 2. Vessels. 3. 4. The embryo. D. The husk: 1. Shows where it is thickest. 2. Shows in what manner the embryo is contained within the duplicature of the husk. F. The two cotyledons, showing the vascular structure upon their surface. * 1. 2. 3. The embryo or corcule. 2. The plomule (*plumula.*) 3. The radicle (*radicula.*) E. One half of a dry Bean. 1. The radicle. 2. The duplicature. 3. 3. The cotyledons. G. One of the lobes or cotyledons of the Kidney-Bean 1. The embryo. H. The same when further advanced in growth. 1. The seminal leaves (*folia seminalia,*) or plumule developed into leaves 2. The radicle. I. A Kidney-Bean. i. The hilum. K. The kernel (*nucleus*) of the Filbert-nut (Corylus Avellana.) L. One of the lobes of the same. i. The embryo. M. The seed of the Common Persimmon (Diospyros virginiana.) N. One of the lobes of the same, with the embryo of its natural size. O. A magnified view of the same embryo, exhibiting the beautiful vascular structure of the plumule.

PLATE VI.

This plate is intended to show the wonderful effects of light upon vegetables. In the superior figure a leaf of a Vine is put through the hole of a stick, in a glass vessel filled with water. The leaf is placed horizontally in the water, with its upper page or surface, looking towards the bottom, and its under surface, towards the top of the glass. A taper is placed at a small distance from the vessel. After some time, owing to the action of the light upon the plant, it turns itself in the vessel, and presents its upper surface to the light.

In the two lower figures, the effect of light is demonstrated in another way. A leaf of Mallow (Malva) is suspended in a glass vessel, filled with water, in a perpendicular direction, in such a manner, that the upper page of the leaf, as in the former instance, regards the bottom of the glass. After some time the plant, in order to receive the influence of light, twists itself, and presents its upper surface to the light. This change is supposed to take place in one and the same vase, but it was thought proper to notice the phenomenon in two distinct drawings.

PLATE VII.

The Dionæa Muscipula, or Venus's Fly-trap is figured upon this plate. This singular vegetable is a native of the State of North-Carolina, where it grows in boggy ground. The leaves are all radical (*folia radicalia.*) The stem is a scape (*scapus.*) Each leaf is terminated by a very remarkable apparatus, which is endued with such an highly irritable power, that if an insect alight upon it, or if it be touched wit'

a pin, the part immediately closes, and retains the irritating object.—See the Plate.—A property somewhat similar to this, is enjoyed by many other plants, such as some species of Sundew (Drosera rotundifolia, &c.,) to which the Dionæa is nearly related by its botanical characters:—the Apocynum androsæmifolium;—and I have discovered it in the Asclepias syriaca, or Syrian Swallow-wort, commonly called Wild-Cotton, and Cotton-plant.

PLATE VIII.

This plate is intended to illustrate the class Monandria. Fig. 1. Canna glauca, a native of North-Carolina, and other Southern parts of the United States. A. A. a. The perianth. B. C. D. Depending petals, or divisions of the monopetalous corolla. E. F. G. Other parts of the corolla. H. g. Tube of the corolla. I. The anther attached to the edge of the petal F. which serves it in place of a filament. K. The stigma. L. The germ, which is inferior (*germen inferum*,) and scabrous.

Fig 2. Canna indica, another species of the same genus. A. A. a. The perianths. B. The Corolla. C. The anther. D. The stigma. E. The germ. e. The persisting stigma, adhering to the germ. Fig. 2.* Part of the above. a. The germ enlarged into a pericarp, which is a capsule (*capsula*.) b. The persisting stigma.

Fig. 3. Different parts of the Common Horse-tail (Hippuris vulgaris.) A. A. a. a. The flowers, in the bosom of the verticillate leaves (*folia verticillata*.) B. B. The germ, which is inferior. b. The calyx. C. The style. c. The stigma. D. The filament (*filamentum*,) terminated by d, the anther, which is two-cleft or cloven (*bifida*.)

The two species of Canna are natives of North America. Hippuris is not known to be a native.

PLATE IX.

The whole of this plate is appropriated to the illustration of the class Diandria, and the order Monogynia. Fig. 1. Cunila Mariana, commonly called in the United States, Dittany, Mountain-Balm, &c. &c. A. A. A. The corymbs (*corymbus*) of flowers. B. The perianth, without the corolla, or the sexual organs. C. The perianth with the corolla, the two stamens, and the pistil. D. The perianth with the pistil only.

Fig. 2. An American species of Speedwell (*Veronica*). The leaves are opposite (*opposita*,) and sessile (*sessilia*.) A. A. The spikes supporting the flowers, each of which has two stamens, and one pistil. a. The perianth, with the corolla, before it has opened. b. A posterior view of the corolla, with its perianth. c. The corolla, with the two stamens and one style.

Fig. 3. Collinsonia canadensis, commonly called Horse-weed, and

Knot-root, because horses are remarkably fond of the plant, and because its root is very hard and knotty.

A. A. The two corymbs (*corymbus.*) b. The perianth. B. The corolla, which is somewhat ringent (*subringens.*) C. The stigma, supported by its style, between the two stamens with their anthers. D. The two anthers, with the pistil between. E. The terminal corymbus (*corymbus terminalis.*)

This is the plant to which Dr. Darwin has alluded in the following lines:

> "Two brother swains,* of Collin's† gentle name
> The same their features, and their forms the same,
> With rival love for fair Collinia‡ sigh,
> Knit the dark brow and roll the unsteady eye,
> With sweet concern the pitying beauty mourns,
> And soothes with smiles the jealous pair by turns."
>
> *Loves of the Plants.*
> Canto i. l. 5i—56.

These lines relate to a circumstance familiarly known to the botanists. At the time when the pollen is matured and consequently, fitted to fertilize the germ, the female organ *voluntarily* moves first to one of the anthers, and having received its influence, then bends towards the other anther, from which, also, it receives the impregnating powder. Similar movements of the pistil are observed in many other vegetables: but instances of the movements of the stamens towards the pistil are still more numerous.

PLATE X.

This plate is illustrative of the two classes Triandria and Tetrandria.

Fig. 1. Commelina virginica, a beautiful North American plant, common in Virginia, and other parts of the United States. A. A. The calyx, which is a spathe (*spatha,*) heart-shaped (*cordata.*) B. B. b. The petals. C. C. The three nectaries, as L. calls them: they resemble stamens, or rather cross-shaped anthers, situated upon their proper filaments. Jussieu and other writers call these, infertile stamens, which I deem a more proper language than that of L. E. F. The leaves, which are alternate (*alterna,*) and lanceolate (*lanceolata.*)

Fig. 2. Ludvigia alternifolia. A. A. The stem from which proceed the leaves. B. B. B. B. These are generally alternate, and lanceolate (*lanceolata.*) But the leaves of this species are not constantly

* The two stamens.

† This plant was named, by Linnæus, in honour of Mr. Peter Collinson, of London, an eminent merchant, and a lover and patron of botany and natural history.

‡ The pistil.

alternate: sometimes the same plant supports both alternate and opposite leaves C. One of the segments of the calyx, which is a perianth, and four-parted (*perianthium 4-partitum.*) D. D. The corolla, which is tetrapetalous, or four petalled (*tetrapetala.*) The stamens are four, and there is one style. E. The capsule, invested by the calyx. F. The pericarp, which is a capsule, four cornered (*capsula tetragona.*)

Fig. 3. Part of Callicarpa americana, called Bermudian Mulberry. A. The perianth. B. The perianth, with the corolla, four stamens and one style.—Tetrandria Monogynia.—C. The fruit or berries, not arrived at their full size, growing around the stem, in a whirl (*verticillus.*) D. A Berry of its natural size when ripe. The calyx is permanent, or adheres to it.

PLATE XI.

Fig. 1. Common Tobacco (Nicotiana Tabacum. A. A. A. Perianths. B. The corolla, before it has opened. C. The tube of the corolla. D. The limb (*limbus*) of the same. E. The swollen germ in the perianth. e. e. e. Bractes (*bracteæ.*) F. The tube. G. The corolla cut open to show H. the stigma, surrounded by the five anthers. I. The pericarp opened. K. The same horizontally cut.

Fig. 2. A species of Ground Cherry (Physalis pennsylvanica?) A. The rotate corolla (*corolla rotata.*) B. A posterior view of the corolla, showing the perianth.

Fig. 3. A species of Convolvulas from Florida. A. The perianth. B. The tube of the corolla. C. The limb of the same, within which are seen the stigma, and five anthers.

All these figures are illustrative of the class Pentandria, and the order Monogynia.

PLATE XII.

Zanthorhiza apiifolia, commonly called Yellow-root. This fine shrub is a native of North Carolina, and other southern parts of the United States. The root and the wood furnish a fine but not lasting, yellow dye. They are also very bitter, and nearly allied to the Columbo, but less pure. See *Medical Repository*. Vol. V. No. ii.) A. A branch of the plant. The leaves are petiolate, or furnished with petioles (*petiolata,*) unequally pinnate (*impari-pinnata.*) a. The corolla which consists of five petals, somewhat magnified. b. A branch of the plant with seed-vessels. c. A single seed-vessel, which is a capsule, one celled (*unilocularis.*) d. One of the capsules opened. e. A seed. f. A portion of the root, sending off a scion (*radix stolonifera.*)

PLATE XIII.

Fig. 1. Hypoxis erecta, or Upright-Star of Bethlehem. This is a very common plant in Pennsylvania, and many other parts of the United States. It grows in woods, &c. A. The bulb, which is esteemed by some a remedy against the bite of the rattle-snake. B. The scape. C. Bractes, which are awl-shaped, (*bracteæ subulatæ.*) The leaves are all radical (*radicalia,*) and grass-like (*graminea.*)

Fig. 2. Lilium canadense, or Canadian Lily. This is a beautiful and common plant in many parts of the United States. A. The squamose bulb (*bulbus squamosus.*) B. One of the individual scales of the same. One of the flowers is unopened; the other is open, and shows the six stamens, and one style. The corolla is bell-shaped and six petalled (*corolla campanulata,* 6-*petala.*)

Both of these plants illustrate the class and order, Hexandria Monogynia.

PLATE XIV.

This plate represents the Medeola virginica, commonly called Indian Cucumber, from the taste of its root, or bulb, which is very similar to that of a Cucumber. It is a very common plant in many parts of the United States, growing in wettish woods.—The leaves are beautifully verticillate (*verticillata.*) There is no calyx in the language of L. but a corolla (which Jussieu calls the calyx:) which is six parted (6-*partita,*) and revolute (*revoluta*).——A. A single stamen. B. The three styles. C. The fruit, which is a berry (*bacca,*) containing three seeds (3-*sperma.*) D. One of the seeds.

This plant is a good illustration of the class Hexandria, and the order Trigynia.

PLATE XV.

Fig. 1. Æsculus parviflora of Walter. This is a native of the Carolinas and of Georgia. A. A flower, the corolla consisting of four petals, with seven stamens and one style. B. the germ considerably enlarged, with the persistent style, after the fall of the stamens. C. c. The sexual organs of the same plant, showing how, in the early flowers, the stamens exist with only the rudiment, c. of the pistil.—This plant, therefore, in strict propriety, belongs to the class of Polygamia.—D. the pericarp (*pericarpium,*) which is three-valved (*trivalve.*) E. the seed, which is a nut (*nux,*) distinguished by a very large hilum.

The leaves of this species of Æsculus afford a very good example of

that species of compound leaf (*folium compositum*) which L. calls the digitate leaf (*folium digitatum.*)

Fig. 2. The flower of the Æsculus flava of Aiton. This is a common tree in many parts of North America, from the latitude of 40 degrees southward. It is known by the names of Buck-eye, and Deers-eye, from some resemblance of its nut to the eye of the common deer. A. The perianth. B. The corolla, which consists of five petals. The stamens are seven in number.

Fig. 3. The flower of the Æsculus Pavia. A. The perianth. B. The corolla, which consists of only four petals.

PLATE XVI.

The upper division of this plate is illustrative of the class Octandria: the lower of the class Enneandria. Fig. 1. Rhexia virginica, a beautiful North American plant. The leaves are opposite and sessile (*folia opposita, sessilia.*) A. A. The calyx, which is a perianth. a. A corolla not yet opened. b. D. The pistil. B. B. The corolla which consists of four petals, that are inserted into the calyx. C. The pistil surrounded by the eight stamens. E. The vascular calyx opened to show the position of the eight stamens, F.—The filaments are terminated by falcated anthers (*antheræ falcatæ.*) G. The germ. H. The pistil. I. The pericarp, crowned by the four points of the calyx.

Fig. 2. Gaura biennis. This is also a common North American plant. A. The calyx. B. B. The four petals of the corolla. C. C. The eight stamens. D. The stigma, which is four lobed (4-*lobum.*) E. The flower not yet opened. F. The pericarp, which is a capsule.

Fig. 3. Different parts of the fructification of the Botumus umbellatus, or Flowering-Rush, which is a native of Britain. A. A posterior view of the corolla, as L. calls it. It is the coloured calyx (*calyx coloratus*) in the language of Jussieu. B. An anterior view of the same. C. The nine stamens, the petals or calyx being removed. c. The receptacle (*receptaculum.*) E. f. The same magnified. D. The six germs, magnified. F. A single stamen, magnified. G. An anther magnified, showing its peculiar structure, which is bilamellate or two-plated (*anthera bilamellata.*)

PLATE. XVII.

Fig. 1. Cassia marilandica, a very beautiful but common American vegetable. It grows abundantly in the vicinity of Philadelphia.—A. A. Glands (*Glandulæ,*) seated on the common petiole, or middle rib, B. B. We have here a good example of that species of compound leaf, which is denominated a pinnate leaf (*folium pinnatum.* c. An anterior view of a blossom not yet opened. D. The three superior petals.

E. One of the two inferior petals. F. G. Seven of the ten stamens. H. The three remaining stamens, the anthers of which are long and bowed. I. The pistil.—This figure illustrates the class and order Decandria Monogynia.

Fig. 2. The sexual organs of the white Saxifrage (Saxifraga granulata,) of which the root is figured in Plate II. A. A. The ten stamens. B. The two pistils.—Decandria Digynia.

Fig. 3. Cucubalus stellatus, a very common American plant. It grows abundantly in the vicinity of Philadelphia. A. The leaves which are stellate (*folia stellata.*) a. Smaller stellate leaves. B. b. Bractes (*bracteæ.*) C. The perianth. D. One of the ten stamens. E. The three styles in the centre of the stamens. F. The three styles detached from the other parts. Decandria Trigynia.

Fig. 4. A. The flower (of its natural size) of the Common Poke (Phytolacca decandra.) B. The same magnified, showing the ten stamens, the striated germ, and ten stigmas.—Decandria Decagynia.

PLATE XVIII.

Fig. 1. Philadelphus inodorus, a beautiful North American vegetable. The petals are four in number. A. The calyx and the sexual organs, detached from the petals. a. a. a. a. The calyx which is a perianth monophyllous, or consisting of one leaf, and four parted (*perianthium monophyllum, quadripartitum.*) b. b. c. c. The stamens which are numerous, and attached to the calyx. d. The four stigmata. B. The calyx, with the germ, e. after impregnation, and the styles, f.—Icosandria Tetragynia.

Fig. 2. A. B. C. A flower before it has opened, of the May-Apple, called also Wild-Lemons, Mandrake, &c. It is the Podophyllum peltatum of L. and is a very common plant in many parts of the United States. A. The peduncle (*pedunculus.*) B. The perianth. C. The petals. D. The expanded blossom, of its natural size. The petals vary in number from six to ten. The most prevailing number is six. The number of the stamens is very various. E. A stamen. e. The filament. f. The anther. F. The fruit which is a berry (*bacca.*) i. The persisting stigma. G. A seed.

PLATE XIX.

This plate is appropriated to an illustration of the 14th, the 15th and the 18th classes of the sexual system.

Fig. 1. Gerardia flava. A. The corolla, which is monopetalous (*monopetala,*) ringent (*ringens,*) the limb (*limbus*) five-parted (*5-partitus.*) The stamens are four in number, two longer than the other two. There is one pistil. B. The pericarp, which is a capsule (*cap-*

sula) seated in its calyx, which is a perianth, monophyllous, and five-parted.—Didynamia Angiospermia,

Fig. 3. Different parts of the Stock Iuly-flower (Cheiranthus incanus.) A. The four stamens and the pistil, of their natural size. B. The same magnified. Four of the stamens are long, and two short, which is the character of the class Tetradynamia.—The base of the shorter stamens are surrounded with four nectariferous glands (*glandulæ nectariferæ.*) C. The corolla, which is tetrapetalous (*tetrapetala,*) and cruciform, or cross-shaped (*cruciatas cruciformis.*)

Fig. 2. Hypericum kalmianum. A. The corolla, which consists of five petals, and the stamens distributed into several different bundles, or phalanges. The pistil in the centre. B. The calyx, which is a perianth, five parted (*quinquepartitum*) with the pistil. C. The perianth, which is a capsule with the calyx attached to it.

Gerardia flava and Hypericum kalmianum are both North American plants. Cheiranthus incanus is not a native.

PLATE XX.

Napæa hermaphrodita, a native of many parts of the United States. A. Shows the filaments united into a single bundle, below, which is the character of the class Monadelphia, which this plate is intended to illustrate. B. The pericarp, which is a capsule. C. One of the cells of the capsule, with the seed contained within. D. A single seed.

PLATE XXI.

Robinia viscosa, a native of the southern parts of the United States. This plate furnishes us with a good example of the pinnate leaf (*folium pinnatum,*) and of that species which L. denominates *folium pinnatum cum impari;* unequally pinnate, when the wings composed of leaflets are terminated by a single leaflet. A. The seed-vessel, which is a legume (*legumen.*) B. The same opened, showing the two valves of which it consists, and the seeds fixed along one of the sutures.

Fig. C. represents a lateral view of a flower of Robinia viscosa. One of the *alæ* and a part of the *vexillum* are chiefly seen. Fig. D. represents more distinctly the *carina,* and the two *alæ.* The sides of the *vexillum* are also seen. Fig. E. represents the *carina* separated from the other petals of the flower. Fig. F. exhibits the *vexillum.*

Robinia viscosa (unknown to L.) is a native of the southern parts of the United States, such as the two Carolinas, Georgia, &c. The viscus matter of its branches, from which the tree derives its name, is a good deal of the nature of caoutchouc.

PLATE XXII.

Tragopogon virginicum? or Virginian Goats-beard. It is a common plant in Pennsylvania, and other parts of the United States. A. The amplexicaule leaf (*folium amplexicaule.*) B. b. Stipules (*stipulæ.*) C. The calyx, with the contained corolla, &c. D. A posterior view of a flower, exhibiting the common calyx. E. E. The corolla. e. e. e. The stigmas. F. A single floscule. f. The petal. g. The cylinder of anthers. h. The style protruded through the anthers. G. The seed, with the pappus, or aigrette, attached to it.—This plate illustrates the first order (Polygamia æqualis) of the class Syngenesia.

PLATE XXIII.

Helianthus divaricatus? a native of Pennsylvania, and other parts of the United States, is figured upon this plate, which is intended to illustrate the second order (Polygamia Frustranea) of the class of Syngenesia. A. A posterior view of the flower, exhibiting the imbricate calyx (*calyx imbricatus.*) B. B. The ray (*radius*) of the corolla. C. A ligulate floret of the ray. D. A tubulose floret of the disk (*discus.*) d. The cylinder of anthers. e. The stigmas. E. A ripe seed. H. A transverse section of the same, showing its angles. G. The two opposite and sessile leaves (*folia opposita, sessilia.*) H. H. H. H. Smaller leaves.

PLATE XXIV.

Silphium terebinthinum, a North American plant. A. B. A posterior view of a flower, exhibiting A. the common calyx, which is an imbricate perianth (*perianthium imbricatum.*) B. One of the ligulate petals of the ray. C. C. An anterior view of the corolla, exhibiting the ray (*radius,*) the petals of which are merely furnished with the female organ; and the disk (*discus,*) the florets of which are tubulous, and furnished with stamens, and an imperfect style, or style without stigma. D. A ligulate petal of the female floret in the ray. E. The perfect stigma. F. The seed. G. The male floret of the disk. H. The cylinder of five anthers, through which is protruded the female organ I, which however, is a style without a stigma. Accordingly, the seed cannot be fertilized without an intercourse taking place between the male floret of the centre and the female floret of the ray. Illustrative of the order Polygamia Necessaria of the class Syngenesia. K. The unopened calyx with the contained corolla, &c. L. L. L. L. Small stem-leaves, or stipules. The principal leaves are radical.

PLATE XXV.

Passiflora incarnata, a native of the United States. It is sometimes called Passion-flower, but more commonly May-apple. A. The three-lobed (*trilobum*,) and serrated (*serratum*) leaf. B. Another leaf supposed to be eaten off at the end, by some species of insect. C. C. Two glands, situated at the termination of the petiole (*petiolus*,) or commencement of the leaves. These glands form a part of L.'s specific character of this species of Passiflora, which he thus defines: "P. foliis serratis aequalibus: petiolis biglandulosis." D. D. *Cirri*, tendrils, or claspers. E. The five-leaved calyx (*perianthium pentaphyllum*,) coloured, and resembling petals. e. Glands, near the base of the flowers. F. One of the five petals of the corolla, which terminate obtusely and not in points, as do the leaves of the calyx. G. The nectary (*nectarium*,) which is said "to crown the corolla." H. The three styles. I. The germ, with the stamens below. The stamens are five in number, but only four of them are visible in this drawing. L. arranges this plant in the order Pentandria of the class Gynandria. By others, it is thrown into the class Pentandria, and the order Trigynia; and by others again into the order Pentandria of the class Monadelphia.

PLATE XXVI.

Cleome pentaphylla. The genus Cleome is arranged by L. in the class Tetradynamia, but the species which is here figured, is certainly not a Tetradynamous plant. A. A. The compound leaves (*folia camposita*,) which are quinate or digitate (*folium quinatum, s. digitatum.*) a. a. a. a. a. The sessile leaflets (*folia sessilia*). B. B. Peduncles (*pedunculi*) supporting the pericarps, C. C., which are siliques. D. D. Perianths, which consist of four leaves (*calyx tetraphyllus*,) from which arise the four petals, the claws (*ungues*) of which are very long, and linear. E. The six stamens of a fertile flower. F. The germ. G. The germ of an abortive flower. H. H. The six stamens. I. The corymb (*corymbus*) of flowers. This plate may serve to illustrate the order Hexandria, of the class Gynandria.

PLATE XXVII.

Fig. 1. Betula populifolia, a native of Pennsylvania, and other parts of the United States. A. A. The male ament, or catkin (*amentum.*) B. B. The female flowers. C. C. Receptacles, such as support the male flowers.

Fig. 2. A portion of the Virginian Polypody, or Male-Fern. This

is a true dorsiferous Fern, the fructification being fastened upon the back of the frond. A. A. Two of the fructifications upon the back of the frond.—Cryptogamia Filices.

Fig. 3. Clavaria Acrospermum, represented of the natural size, as growing upon old, dry wood.

Fig. 4. The same magnified.—These two figures, which may serve to illustrate the order Fungi in the class of Cryptogamia, are copied from Professor Hoffman's *Flora of Germany, or a Botanical Pocket Companion, for the year* 1795. Volume II. Erlangen.

PLATE XXVIII.

Sagittaria sagittifolia, or Common Arrow-head. This is a very common plant in many parts of North America, as well as in Europe and Asia. A. A portion of the root and the commencement of the leaves. Beside this root, there is always a bulb at the lower part of the root, growing in the solid earth, beneath the mud of the place in which the plant grows. This bulb, when boiled or roasted, is agreeable food, and the plant is cultivated by the Chinese. B. The scape (*scapus.*) b. Bractes (*bracteæ.*) C. D. Petioles supporting the sagittate leaf (*folium sagittatum.*) E. One of the female flowers in perfection, exhibiting the three-petalled corolla (*corolla tripetala,*) and the styles. F. A female flower after the removal of the petals, exhibiting the three-leaved perianth (*perianthium triphyllum,*) and the styles. f. A back view of a female flower. G. G. G. The perfect male flowers, exhibiting the three petals, and the many anthers. I. A back view of a male flower. H. One of the male flowers, not yet opened.

This plate is an excellent illustration of the Class Monoecia, and the order Polyandria. It may, also, serve to illustrate the class Polyandria, and the order Polygynia, to which division of the sexual method it is referred by Thunberg, Withering, Gmelin, and other writers.

PLATE XXIX.

Fig. 1. and Fig. 2. The male and female plants of the Acnida cannabina, a common plant in the neighbourhood of Philadelphia, and other parts of the United States. Fig. 1. The male. Fig. 2. The female. A. A. The spikes (*spica*) of flowers. a. A male flower, exhibiting the five petals, and the five stamens. b. The female flower, exhibiting the perianth, with the germ and five styles. c. The pericarp, which is a capsule (*capsula.*) This is a good example of the class Dioecia and the order Pentandria. Gmelin and other writers have referred this plant to the class Pentandria, and the order Pentagynia.

All the figures, in the lower division of this plate, are different parts of the Veratrum album, or White-Hellebore, and are intended to illus-

trate the class Polygamia, and the order Monoecia. A. The hermaphrodite flower, exhibiting the six-petalled corolla (which Jussieu calls a calyx, "Calix æqualis coloratus,") with the six stamens, and three germs. B. The corolla without the stamens. C. The six stamens separated from the other parts. D. The three germs. E. The germ magnified. F. A stamen magnified. f. The anther. G. The male flower. I. The six stamens. H. h. The corolla of the male flower.

This plant is referred, by Gmelin and other writers, to the class Hexandria, and the order Trigynia.

PLATE XXX.

The first four figures upon this plate are illustrative of the class Dodecandria; the remainder of the class Cryptogamia.

Fig. 1. A. B. C. D. E. Different parts of the Asarum canadense, or Canadian Asarabacca, commonly called Wild-Ginger, and sometimes Colts-foot. A. The germ below the calyx, and hid within the substance. B. The stellate or star-shaped stigma (*stigma stellatum,*) six-parted (*sex-partitum.*) b. b. Six of the twelve stamens: the other six have been removed, but the places which the filaments had occupied, are seen. C. The twelve filaments, inserted on the top of the germ. The filaments are subulate or awl-shaped (*filamenta subulata,*) with the anthers joined near to the middle of the filaments. D. E. Two of the stamens, somewhat magnified.—Dodecandria Monogynia.

Fig. 2. The flower of Common Agrimony (Agrimonia Eupatoria,) of its natural size. Fig. 3. The same magnified. The corolla is five-petalled *(pentapetala.)* The stamens are twelve, the styles two.—Dodecandria Digynia.

Fig. 4. Euphorbia Lathyris, or Caper-Spurge. The parts are magnified. A. The twelve stamens. B. The germ. b. b. The styles. a. The six stigmas.—Dodecandria Trigynia.

Fig. 4.* Jeffersonia binata, *mihi:* Jeffersonia Bartonis of Michaux: Jeffersonia diphylla of Persoon, &c. The writers whom I have mentioned, have followed me in referring this legitimate genus to the class Octandria: but a more critical examination of the plant has convinced me, that it more properly belongs to the class Dodecandria (so far as that class may be permitted to stand;) of which it is here offered as an illustration: or to the class Polyandria.

Fig. 5. A little turf of a Moss (the Bryum murale,) in fructification. This is represented of the natural size.

Fig. 6. A detached individual of the same Moss, magnified. A. The stem. B. The capsule, to which L. gave the erroneous name of *anthera.* This is the *pyxidula* of some writers. The French call it pyxidule. C. The calypre *(calyptra,)* which L. considers as a species of calyx.

Fig. 7. Another Moss. A. The stem. a. B. The pendant pyxidule, or capsule. b. The peristome.

Fig. 8. A. The capsule, which is cylindrical. B. The convex opercule, or lid (*operculum*,) which covers the capsule. C. The calyptre, detached.

Fig. 9. The capsule of the Moss, represented in Fig. 7., considerably magnified. A. The hollow part, which contains the powder. B. The solid base of the same. C. The peristome (which Hedwig calls the *peristomium* or *peristoma*) furnished with straight teeth. The peristome was noticed by the great Dr. Haller, who called it *corona*, and was, I believe, the first person, who intimated, that the Mosses might be arranged according to this part. D. The opercule. E. The ring of the peristome.

Fig. 10. A. The naked peristome. B. The opercule detached.

Fig. 11. & Fig. 12. Leaves of certain species of Mosses.

Fig. 13. The fructification of a Lichen.

Fig. 14. The funnel-shaped fructification of a Lichen.

Fig. 15. The fructification of the genus Marchantia. A. The escutchion-like, or target-shaped, fructification (*pelta.*) .B. A cup which contains corpuscules, which are reproductive of other plants. These corpuscules, which are often lentile-shaped, are perfect young plants, each formed at once from the parent plant, or else springing from seed deposited thereon.

Fig. 16. The fructification of the genus Jungermannia. A. The tubulous sheath, embracing the stem. B. The stem or fruit-stalk. C. The capsule, or pyxidule, which is four-valved (*pyxidula quadrivalvis*,) and contains the seeds, which are attached to elastic cords. These seeds, whatever may be their intimate nature, have proved, upon trial, to reproduce their respective plants.

Fig. 17. Peziza lentifera:* two views. B. represents a section of the plant, to show more distinctly the flattened seed, or sporæ. Withering calls them "capsules." Cryptogamia Fungi.

Fig. 18. Asplenium rhizophyllum, pushing out radicles and new leaves (fronds) from the extremity of the parent frond.—The irregular fructification is seen on the back of one of the fronds. "Asplenium (*rhizophyllum*) pusillum, glabrum; frondibus simplicibus, subhastato-lanceolatis, integris, *summitate cirrhosa radicantibus*: fructificatione lineis brevibus, inordinate sparsis." *Michaux*, *Flor. bor. amer.* ii. *p.* 264.

This is a common plant in many parts of the United States, Canada, &c., growing in rocky situations. The student will meet it, in abundance, in his excursions along the Wissihickon, in the vicinity of Philadelphia: and the curious traveller will find it on the rocks, at the entrance of the beautiful and extensive calcareous cave, called Amos's, in the counties of Rockingham and Augusta in Virginia.

* Linn.—Nidularia campanulata of Withering. vol. iv. p. 350.

There is a variety of this species of Asplenium with a pinnatifid frond: Asplenium rhizophyllum, *pinnatifidum*.

PLATE XXXI.

All the figures on this plate are intended to illustrate the order Musci, of the class Cryptogamia.

The upper figures represent the Polytrichum perigoniale of Michaux: one of the most common of all the North American plants. The student is here presented with beautiful representations of the *pyxidula* and of the villose *calyptra*, as they occur in this moss.

The figures below the line are devoted to the Bartramia vulgaris* of Michaux: another common American plant. The figure on the left represents the plant of the natural size. The seven remaining figures are all magnified.

PLATE XXXII.

This plate contains representations of a number of the principal forms of *Simple* leaves, drawn for this work by an eminent artist,† from actual specimens, no imaginary forms being admitted. The greater number of the vegetables whose leaves are here represented, are natives of the United States: all those, indeed, of whose native country nothing is said.

Fig. 1. *Folium lineare:* Aster linearifolius. 2. *fol. subulatum:* Phascum subulatum. 3. *fol. lanceolatum*: Polgyonum Persicaria. 4. *fol. ellipticum:* Magnolia glauca, common Magnolia, or Beaver-tree. 5. *fol. obovatum*: Arbutus Uva ursi. 6. *fol. cuneiforme*: Quercus nigra. N. B. This is the true Black-Oak, or Black-Jack, of the United States, and must not be confounded with Quercus tinctoria, which is also called Black-Oak.—7. *fol. spathulatum*: Polygala lutea. 8. *fol. acutum*: Solidago odora. 9. *fol. acuminatum*: Cornus alterna, *seu* alternifolia. 10. *fol. setaceo-acuminatum*: Quercus Phellos, or Willow-leaved Oak. 11. *folium orbiculatum*: Glycine tomentosa. 12. *fol. peltatum*: Hydropeltis purpurea of Michaux; and Ixodia palustris of Solander. 13. *fol. perfoliatum*: Uvularia perfolia. 14. *fol. connatum*: Eupatorium connatum of Michaux: Eupatorium perfoliatum of L. 15. *fol. amplexicaule*: Conyza amplexicaulis; a native of the East Indies. 16. *fol. auriculatum*: Magnolia auriculata. 17. *fol. cordatum*: Pentederia cordata. 18. *fol. obcordatum*: Oxalis acetosella. 19. *fol. emarginatum*: Astragalus emarginatus; a native of the East. 20. *fol. reniforme*: Asarum canadense. 21. *fol. sagittatum*: Polygonum sagittatum,

* Bartramia pomiformis of Hedwig.

† Mr. Redoute of Paris.

called Tear-thumb, and Turkey-seed. 22. *fol. hastatum:* Polygonum hastatum. 23. *fol. deltoides*: Populus nigra. 24. *fol. rhombeum*: Sida rhombifolia. 25. *fol. dentatum:* Populus grandidentata. 26. *fol. serratum:* Fagus Castanea. 27. *fol. duplicato-serratum:* Betula nigra, Linn. 28. *fol. crenatum:* Quercus Prinus, *monticola.*—This is the Chesnut-oak of Pennsylvania.—29. *fol. repandum:* Hydrocotyle . . . . 30. *fol. undulatum:* Asclepias obtusifolia. 31. *fol. laciniatum:* Rudbeckia laciniata. 32. *fol. sinuatum:* Argemone mexicana. N. B. I must consider this as one of the indigenous plants of the United States.—33. *fol. panduratum:* Convolvulus Imperati; a native of Egypt, Italy, &c. 34. *fol. lyratum:* Senecio lyratus. 35. *fol. runcinatum:* Leontodon Taraxacum, or Common Dandelion. I now incline to consider this as truly indgenous in North America.—36. *fol. lobatum:* Liriodendron Tulipifera, or Tulip-tree; called also Poplar, Canoe-wood, &c. &c.—37. *fol. palmatum:* Viola palmata. 38. *fol. trilobatum:* Anemone Hepatica. 39. *fol. palmato-lobatum:* Liquidambar Styraciflua, called Sweet-Gum, Bilstead, &c. See Catesby, *Carol.* p 65. t. 65. 40. *fol. multipartitum:* Crysocoma corona. 41. *fol. pinnatum:* Proserpi-naca palustris.

PLATE XXXIII.

This plate is wholly devoted to the forms of *Compound* and doubly-compound Leaves. The figures were done expressly for this work, by Mr. Redoute.

Fig. 1. *Folium conjugatum, vel binatum:* Zygophyllum Fabago; a native of Syria, Mauritania, Siberia, &c. 2. *fol. ternatum:* Trifolium pratense, or Red-Clover, now very extensively *naturalized* in the United States. 3. *fol. ternatum: foliis duplicato-serratis:* Spiraea trifoliata, or Indian Physic; 4. *fol. quaternatum*: Zornia tetraphylla. 5. *fol. digitatum;* Tesculus Pavia. See explan. of Plate XV. Fig. 3. 6. *folium digitatum; foliolis septenis:* Lupinus perennis, or Perennial Lupin, an extremely common plant in the vicinity of Philadelphia. 7. *fol. peaatum:* Helleborus fœtidus: 8. *fol. pedatum; foliis compositis:* Adiantum pedatum; called Maiden-hair, and Mow-hair. An extremely common, as well as beautiful, plant within the limits of the Botanical Excursions, in the neighbourhood of Philadelphia.—9. *fol. impari-pinnatum:* Juglans tomentosa, vel squamosa. This is the true Shell-bark Hickory.—10. *fol. abrupti-pinnatum:* Tamarindus indica; a native of the East and West Indies, of Egypt, and Arabia. 11. *fol. cirrhoso-pinnatum;* Pisum sativum, or Common Pea; extensively cultivated in the United States. 12. *fol. pinnatum; foliolis bijugis:* Casisa Absus; a native of India and of Egypt. 13. *fol. bipinnatum:* Mimosa farnesiana. 14. *fol. bipinnatum:* Melia Azedarach, now naturalized in many parts of the United States. 15. *fol. tripinnatum:* Conium

maculatum, or Common Hemlock. Common in many parts of the United States; but if indigenous uncertain.

PLATE XXXIV.

The upper figure, A., represents part of the stem with the leaves, and two flowers, one of which is in the unopened state, of the beautiful Aquilegia canadensis, or Canadian Columbine, one of the earlier flowering North American plants.

Figures, 1, 2, 3, 4, and 5, individual parts of the flower. Fig. 2. exhibits a fine view of the nectarium, which in this plant is the *cucullus.* Fig. 3. shows the insertion of the stamina into the receptaculum, characteristic of the plants of this class, viz. Polyandria.

The remaining five figures represent parts of the flower of Dalibarda fragarioides, of the class of Icosandria.

PLATE XXXV.

The beautiful Coreopsis belonging to the class Syngenesia, and the order Polygamia Frustranea.

Fig. 1. An anterior view of one of the flowers. Fig. 2. a posterior view of the same, showing the calyx, which is double (*duplex*) each consisting of several leaves (*polyphyllus.* Fig. 3. a single petal which is neuter, being entirely destitute both of the pistils and the stamens. Fig. 4. an anterior view of the exterior calyx, showing the seven leaves which compose it, and also the unopened corolla. Fig. 5. a magnified representation of one of the central florets, very distinctly exhibiting the coalescence of the anthers, and the bifid stigma protruded through their centre.

I have said that the plant before us, belongs to the order *Frustranea* of the class Syngenesia. Of this order, indeed, it may be considered as a very good illustration. Among the changes which it has been proposed to make in the difficult, and extensive class of Syngenesia (for no sensible botanist is *entirely* satisfied with this part of the L. system,) authors have suggested the propriety of abolishing the order in question: and I agree with Dr. Smith, that it ought to be abolished. "I should be much inclined (says this writer) to abolish this order. Those of its genera which have rudiments of pistils in their radiant florets" —(the present species of Coreopsis has no such rudiments—"as Rudbeckia and Helianthus, would very commodiously range with their near relations in *Polygamia superflua*, nor are we sure that such radiant florets are, in all circumstances, abortive, neither can a student often know whether they are so or not."

PLATE XXXVI.

This fine plate is intended to illustrate the two classes of Monoecia and Polygamia.

The principal lower figure exhibits the Comptonia asplenifolia, or Sweet Fern, with its five male aments above: the female flowers below.

The eight upper figures exhibit the Acer rubrum, or Red-Maple of the United States. It was not thought necessary to add individual references to the objects on this plate.

PLATE XXXVII.

Was engraved, but is omitted, being useless in this work.

PLATE XXXVIII.

A seedling plant of the Cupressus disticha, or Bald-Cypress, of the United States, showing its five cotyledons, and the young green leaves; all of the natural size.

PLATE XXXIX.

Pyrola umbellata, of the class and order Decandria Monogynia.

This is one of the more common North American plants, extending far south of the limits assigned to it by Michaux, in his *Flora*, vol. i. p. 251. "Pyrola *(umbellata)* foliis cuneato-oblongis: argute serratis: scapo corymbifero: stigmate sessili." Michaux, *l. c.*

Pyrola umbellata is one of the very many North American plants, which are eminently odoriferous. The odour of its flowers is truly fragrant. No observation is more unfounded than that which asserts, that the odour of the vegetables of the United States is feeble?

PLATE XL.

A good figure of the Sanguinaria Canadensis, or Puccoon.

A. The premorse root *(ralix praemorsa.)* B. The under side of a leaf, not yet quite unfolded.—The flower appearing very early in the spring, while the weather is still cold, and frosts not uncommon seems to demand some peculiar protection. It, accordingly, on its first appearance above the ground, and for some time after, is beautifully enclosed in one of the leaves, which forms as it were, a kind of involu-

crum to it. Is the flower thus enclosed and protected, in those more southern parts of the United States, to which the Sanguinaria extends? —C. The upper surface of a fully-expanded leaf. D. An unexpanded flower. d. One of the two leaves of the calyx, which is a perianth, remarkably caducous. E. A stem, *(scape)* supporting an expanded flower. F. The capsule, which is ovate, oblong, attenuated at the end, and mono-locular (1-*locularis.*) N. B. In our figure, the capsule is not enlarged to the utmost size it attains. "Sanguinaria (*Canadensis*) foliis subreniformibus, sinuato-lobatis, scapis unifloris." Michaux, i. p. 309. —The excellent Jussieu is mistaken when he tells us, that Sanguinaria has but one radical leaf." "Folium unicum radicale."

The petals of Sanguinaria connive every evening, for several evenings successively; even after impregnation, if I mistake not.

Sanguinaria, Argemone, Papaper, Glaucium, Chelidonium, Jefforsonia, and a few others, form a fine natural assemblage of plants, between the different genera and species of which there is a beautiful series of affinities. The order *Pavaveraceæ* of Jussieu. In studying the natural families the student will do well to examine all these plants with attention. Their medical properties, too, are, in many respects, very similar.

THE END.

Class XIII.

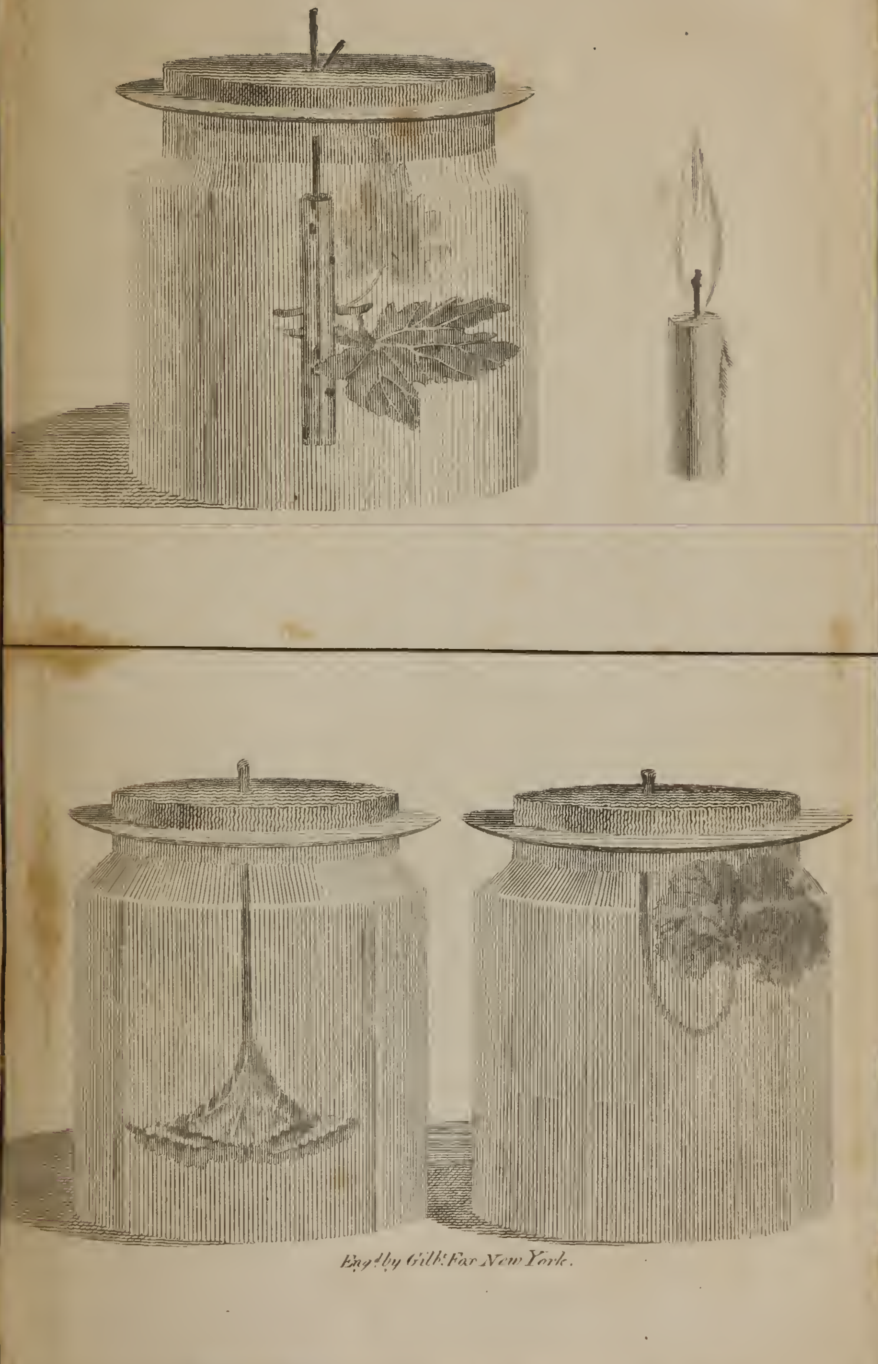

Fig. 1.
Fig. 2.
Fig. 3
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.

Plate III.


Class XIV.
Plate IV.
Bartsia coccinea.
A.
B.
C.
D.
d.
E.
F.
G.
H.
I.
Engrav'd by B. Jones. 1801.


Plate V.
A
B
C
D
E
F
G
H
I
K
L
M
N
O
B. Jones. sc.

Plate VI.



Eng.d by Gilb.t Fox New York.

Fly trap. *Dionaea Muscipula.*

Class X.

Plate VII.

Class 1.

Plate VIII.

Class II.

Classes III & IV.

Plate XI.

Class V.

Class V. Plate XI

Class VI.

Plate XIII.

Class VI.

Plate XIV

Class VII.

Plate XV.

Shallus Sc.

Class VIII.

Class IX.

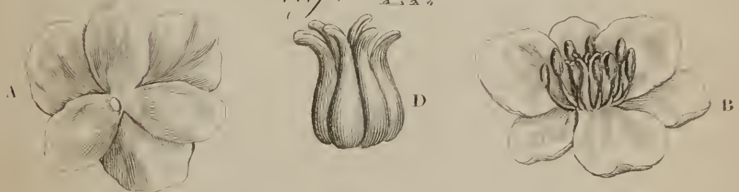
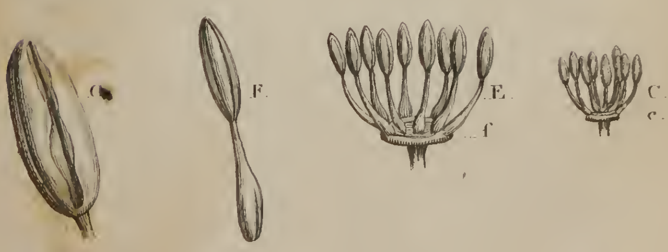


Fig. 3.



Plat

Class X.

Class XII.

Fig 1.

Fig. 2.

Class XIII.


Class XIV.
Plate XIX.
B.
A.
Fig. 1.
Class XVIII.
A
Fig. 2.
C.
B.
Fig. 3.
C.
B.
A.
Class XV.
Tanner Sc.

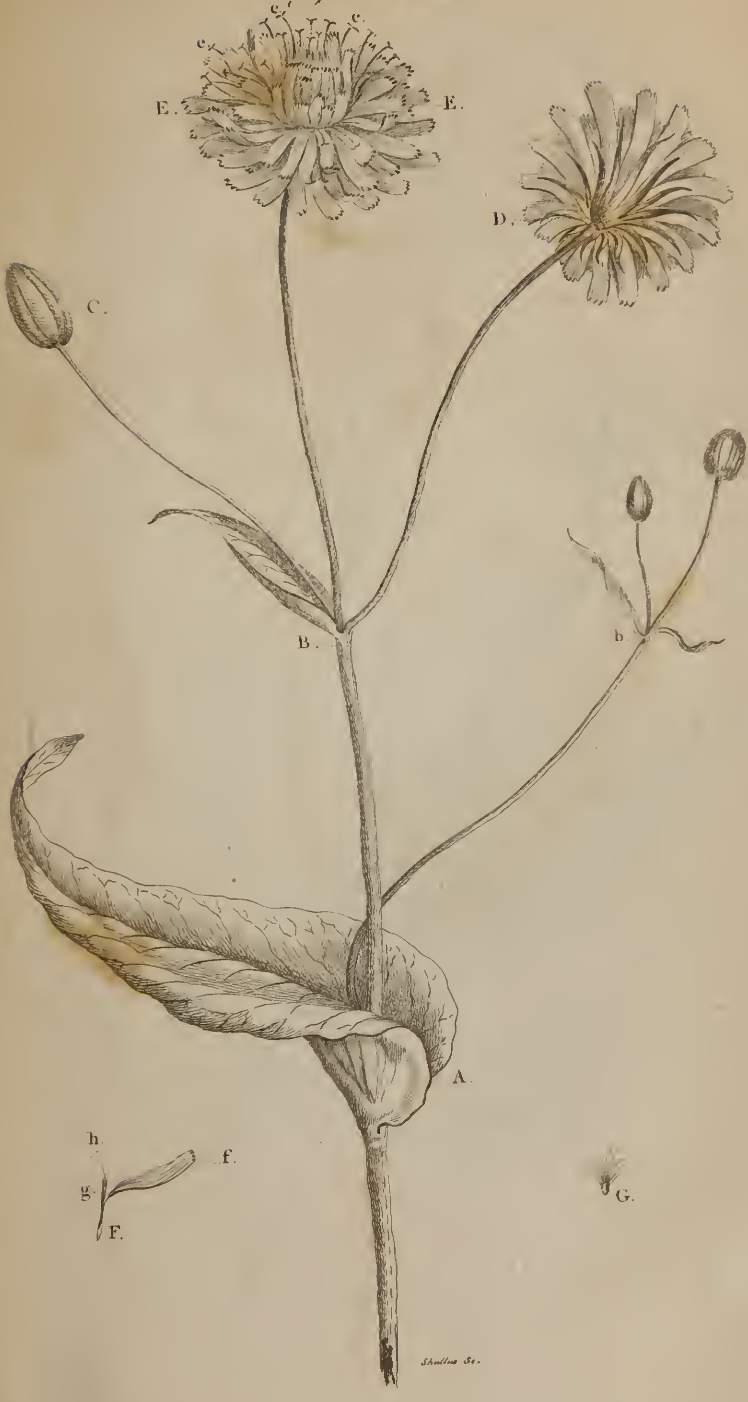
Class XVI. Plate XX.

J.H.Seymour sc

Class XVII.

Plate XXI

Class XIX. Plate XXII.




B.
B.
A.
H.
H.
H.
H.
G.
G.
Class XIX.
e.
d.
C.
D.
E.
F.
c.
Shallus S.

Plate XXIV.

Clafs XIX.

Class XX. Plate XXV.

Class XX.

Tanner sc.

Class XXI.

Fig. 1.

Class XXIV.

Fig. 4.

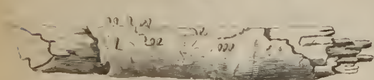


Fig. 3.

Fig. 2.


G.
H.
I.
G.
G.
f.
F.
E.
b.
C.
D.
B.
A.
Tanner sc.

Class XXII.

Class XXIII.

Class XI.

Class XXIV.

Class XXIV. Plate XXXI.

Plate XXXII.


Fig. 1.
2
3
4
5.
6.
7
8
9.
10.
11
12.
13
14.
15.

Classes XII & XIII. Plate XXXIV.

Class XIX. Plate XXXV.

Plate XXXVI.

Pl. XXIII.

Class X. Plate XXXIX.

W. Bartram. del. Tanner, Sc

Pyrola Umbellata.

Class XIII Plate XL.